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AMERICA, ENGLAND, AND GERMANY AS ALLIES FOR THE OPEN DOOR.

By Hon. John Barrett, Late U. S. Minister to Siam.

II.—THE ENGINEERING AND INDUSTRIAL INTERESTS AT STAKE.

HAVING devoted my article in the preceding issue of THE ENGINEERING MAGAZINE to a review of the material and political conditions of China to-day, we can turn to the consideration of China's material possibilities which especially appeal to an engineering constituency. The size of the country, which naturally is a primary consideration, is, in the matter of area, to be viewed from two standpoints: one, that of China proper, or the eighteen provinces forming a compact whole by themselves, and the other of China and her dependencies making the extent more than double that of China proper. According to the estimates of Lord Charles Beresford, the former has an approximate extent of 1,550,000 square miles, and the latter of 4,300,000 square miles. The largest individual province, or state, of China proper is Szechuan, which has, according to Lord Charles Beresford, 218,534 square miles and a population of 45,500,000. It is, moreover, the most interior province of China proper, and seems to possess the greatest variety of material resources. At the present moment English and French companies are competing with each other for the control of the wealth of this great state. It is said to possess resources of coal, iron, and copper unsurpassed in the world, while within its limits are also found silver, lead, salt, and lime. Added to these are the great surface staples of silk and opium, aside from the lesser and more common agricultural products. Trunk railways must soon connect this inland empire with

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Lord Kitchener is quoted as having said, at the opening of the Albara bridge : "Where Englishmen failed, I am delighted to find that our cousins across the Atlantic stepped in. The opening of this bridge to-day is due to their energy, ability, and the power they pos-

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Shanghai and Hong Kong on the east, and with Rangoon and Calcutta on the southwest. When it is understood that there has practically been no development yet of this wonderful province, which is only one small part of China, some conception of China's possibilities may be framed in the layman's mind.

Turning from the largest to the smallest, we have the province of Chekiang, which lies with its full eastern coast line on the North China Sea, just below the mouth of the Yangtze River. Though small in Chinese comparison, it has a population of 10,000,000 and an area of 38,000 square miles. According to Archibald Colquhoun, "Chekiang is renowned alike for its fertility, its forests and fruit trees, its populous towns, and its salubrious climate. Hangchau, the capital, is one of the finest towns in the Empire, and was described by Marco Polo, who visited it in 1286, as 'beyond dispute the noblest in the world.'" When we consider that the conditions throughout this Empire are practically the same as those of one thousand years ago, then we realize what there remains to be done according to the methods of this modern age.

There is no better way to be convinced of the importance, not only of China but of the entire far east, than to study carefully a map of that section. The remarkable coast line that reaches right away from Singapore to Vladivostock, for 4,500 miles, has a variety of conformation formed by the waters of oceans, seas, gulfs, bays, harbors, inlets straits, and channels, which has no counterpart in any other portion of the world. In this mingling of mainland, capes, peninsulas, promontories, and groups of islands, with the separating bodies of water, there are opportunities for the development of commerce and trade which those unacquainted with the geography and resources of the far east would never for a moment appreciate. Already the foreign trade of eastern and Pacific Asia amounts to over $900,000,000, which measures the buying and selling in foreign exchange of 500,000,000 people. This total can only represent a small degree of what the future will show. The commerce of 500,000,000 people must, as they come into closer contact and association with foreign nations, reach, in the comparatively near future, to billions of dollars, if we can take Japan's experience as a criterion. With a population of 40,000,000, she has a

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sess in so marked a degree of turning out work of this magnitude in less time than it can be done anywhere else." The Sirdar's words reflect the perception which is daily growing clearer to the broadest and soundest thinkers. that the newly-opened places of the world need, for their development, the federated efforts of all the great nations. And in this spirit Mr. Barrett appeals, through THE ENGINEERING MAGAZINE, to the engineering and industrial world to se aside narrow and short-sighted jealousy and prejudice and cooperate for one great end, for the common good. THE EDITORS.

foreign trade of $225,000,000, and yet in 1875 it amounted to only $47,000,000. China's foreign commerce is valued at $250,000,000. Placing her population at the lowest estimate of 250,000,000, we have evidence that this trade is only in the infancy of its development. Japan's foreign commerce averages about $5.50 per man, while that of China averages only $1; if we make the possible ratio the reasonable figures of three to one, we have a foreign commerce for China of $750,000,000. It is sometimes contended in this connection that China is too poor to buy, and that she has not sufficient to sell to increase her purchasing power. This argument, however, is only advanced by those who have not made a careful study of China's resources. When the great latent wealth of her interior is developed, and when railroads bring her products to market and allow that exchange and intercourse which Japan is now experiencing, it will be found that China will have abundant buying capacity, and sufficient products to sell and meet the demands of the outer world.

According to the statistics of America's foreign trade just published, we find that the United States exported to Asia and Oceanica during the fiscal year ending June, 1899, products to the value of nearly $80,000,000, or an increase over 1897 of nearly $20,000,000, and nearly $14,000,000 over 1898. The major portion of these exports went to Asiatic countries. At this rate of increase, with the expanding influence of control of the Philippines, and with the awakening to the opportunities in China, Japan, Siam, Corea, Siberia, as they have never been realized before, these figures should soon pass the $100,000,000 mark, and go on, within the next two decades, to $200,000,000 or $250,000,000. In the same year the United States purchased from Asia and Oceanica products valued at nearly $134,000,000. The United States have, therefore, a balance of trade against them of over $50,000,000. This alone should be a sufficient incentive for extraordinary endeavor to develop the market.

The field of exploitation for engineers is, however, one of the most interesting and possibly the most extensive. First, in locating and opening up China's great latent resources of iron, coal, copper, lead, silver and gold; second, in the construction of railways, both trunk and tributary lines, of lesser electric railways, of bridges, buildings, and of all kinds of structures that accompany the building of railways; third, in the control and opening up of waterways, improving rivers, removing bars, dredging canals and channels, building dykes, restraining the vast floods of overflowing streams like the Yellow River, introducing systems of irrigation; fourth, in providing the great cities of China with methods of sanitation, with waterworks, with electric lights, railways and telephones, in extending telegraphic and telephonic systems throughout the Empire, in erecting and managing factories, in building ordinary roads between common points of population and importance; fifth, and at home, in planning to carry out all of these enterprises, gigantic and small, in designing and making the needed equipment, the materials of structure, the supplies for railways, the tools that will be required—in all these and in many other ways the engineers of America, England, and Germany, will have an unprecedented opportunity in Asia to show their ability, and exercise their strong influence for the opening up of a great nation and a mighty people to the civilization, commerce, and methods of the modern European and American world.

In this competition which must go on, I do not fear for the part American engineers will play, if they will only appreciate the opportunity and strive to improve it before it is too late. Many of them have already gone into this field and done extraordinary work. Possibly the most notable recent illustration of what a skilful and persistent American engineer can do is the work of Gen. W. Barclay Parsons,* who has so recently crossed through the southern part of China from Hankow to Canton, and successfully concluded his responsible mission, overcoming obstacles and removing difficulties which would have frightened most men from undertaking the journey. He had opposed to him not only native prejudice, but the influence and, in some respects, unfair competition of some European agents. Towards one and all he pursued the same dogged, but tactful, policy, and accomplished his purpose, which makes him rank among the foremost engineers of America. His example is one which others can afford to follow. In this connection it is well to note one or two other points showing the influence of the American engineer. The chief adviser of Sheng, who is at the head of Chinese railway administration. is another distinguished American railway engineer, Capt. Watson W. Rich. In Corea, the first important railway from Chemulpho to Seoul, and the first electric railway in Seoul, have been built by American engineers. In Siam, the most prominent railway engineer during the last few years has been Mr. Lawrence E. Bennett, an American, who not only had important connections with the Bangkok-Korat railway, but was the moving influence and concessionaire who planned and managed Bangkok's excellent electric-light system, which is now under the charge of Mr. George C. Holberton, another American. The electric street car line in Bangkok was also constructed by American engineers, and the chief stockholder, after the king, was an American, Dr. T. H. Hays.

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*Gen. Parsons is preparing for THE ENGINEERING MAGAZINE a discussion of the opening for engineering and railway development in China, based upon the studies made during his recent trip. THE EDITORS.

Possible railway construction, which appeals more to the engineer than any other class of projects, is a most fascinating subject of study. When it is remembered that in that vast empire of 4,000,000 square miles, and possibly 300,000,000 people, there are not over 350 miles of completed running railways, it is appreciated that the opportunity can be called almost unlimited. The location of the cities of China, the distribution of centres of population, and the conformation of the surface of the land, all point to liberal extension of railways. With great starting points such as Canton or Hong Kong on the south, Shanghai on the east central coast, and Tien Tsin and Peking on the north, and with such objective points as Hankow in the heart of China, Chungking in the far west—several thousand miles of trunk lines are already needed and in sight, as it were, with a sure return on the investment, provided, of course, conditions of government, law, and order are favorable. If these trunk routes are planned and carried out, there must be numerous tributary lines, which will mean as many thousand miles more. Aside from these are the possibilities of early connections between the English railway systems of Burma and India and those projected in China on the west; between the growing system in French Tongking and that proposed in China on the south; and, finally, between the system already started in the north and that of Russia extending right away through Siberia and Manchuria. Germany also has plans for railways in Shantung to the west, connecting with another proposed trunk road along the line of the Grand Canal from Peking to Chinkiang and Shanghai, which is considered by experts to be one of the best routes in all China for freight and passengers. The railway construction planned for the near future in China calls for an investment of more than $100,000,000.

The waterways of China, to which I have made partial reference before, afford another unlimited field for the best engineering efforts. The Yellow River, for instance, presents problems of engineering equalled only by those of the Mississippi. Something must be done by the Chinese government to change or improve the channel of that mighty stream. Under present conditions, millions of lives are endangered every year by its uprisings and floods. It will take vast sums of money and years of labor to restrain it or direct it within limits which will protect both people and land from its awful ravages. The Yangtze River, which is one of the most important in all the world, is not so dangerous in its floods, but needs improvement in its channels and course. The same work is needed, on a lesser scale, in the West River, on which Canton is located, and the Pei-ho, on which Tien Tsin is situated Then there are the bars at the mouths of all these rivers, which should be dredged in order to permit of the free movement of ocean-going steamers. The demands of commerce and trade will make these improvements imperative, even if the government of China is slow to meet the responsibility.

Numerous canals, particularly the Grand Canal, which reaches for 800 miles from the Yangtze to the Pei-ho, should be dredged and opened to the great inland traffic which would surely follow if the mud and filth of centuries were removed from its channel. Lesser canals emptying into it, or located in other sections, require the same class of improvements. As the people of China are especially adapted by habit and taste and experience to life and work on boats, interior traffic on canals will always pay for the money invested to dredge or improve them, provided the government allows them to pass under private control.

Large sections of China would be benefited and made prosperous by the introduction of systems of irrigation modeled upon the same lines as those which have proved successful in America. It may require American engineers to prove this fact to the Chinese, but those who have travelled through the interior of China have seen the great possibilities in this line.

Now a few words regarding the Philippines. After travelling carefully through Nippon, the principal island of Japan, going into the interior and noting present conditions, resources, and possibilities, from the Straits of Sugaru on the north to the Straits of Simonoseki on the south, on the one hand; and after travelling through Luzon, the principal island of the Philippines, from Aparri on the far north to the Straits of San Bernardino on the south, noting carefully in times of peace some years ago the actual resources and apparent possibilities of the island, on the other hand—I can say that, except in the matter of area and population, the comparison is all in favor of Luzon. What I state in this particular as to the resources and undeveloped wealth of the Philippines is supported by every European engineer who has travelled through the islands. Adverse criticisms of the engineering and commercial possibilities of the Philippines come almost entirely from those who draw their conclusions from theory and who have never been to the Philippines, or at least not beyond the confines of Manila, Ilo Ilo, Cebu, and Zamboanga. When I made my first journey there, I not only travelled through Luzon, but through the Visayan, or central, group, and visited also Mindanao and the Sulu Sultanate. That was before war was even expected between the United States and Spain, and I had no reason to seek a favorable impression, but I then made reports and wrote articles speaking of the Philippines as affording one of the greatest undeveloped material opportunities in all the world, and wondering that Spain had been able to keep them so long in darkness.

At the present time there are only 135 miles of railway constructed in the Philippines. From the letters and reports of competent English, German, and Spanish engineers, there could be built 1,000 to 1,500 miles of railways in the islands during the next fifteen or twenty years, which should pay a good return on the investment. Possibly a conservative estimate, including accessories, would be $50,000,000. By careless mistake in copying, these figures were placed at $150,000,000 in some former published statements of mine. I take this opportunity to correct them in a magazine which must be read largely by experts. With such railway construction will come other kinds of development, which will call not only for engineering skill, but for the investment of more capital, and which will provide wider markets for exports. When there is added to these railway possibilities, the needed improvement of rivers and harbors, and the development along modern lines of the great Philippine industries of hemp, tobacco, sugar, copra, rice, spices, together with the latent resources of coal, iron, gold, tin, copper, and other minerals and metals which are proved to exist in paying quantities, we have a realization of the material side of the Philippine problem.

A word in passing about Siam may call the attention of engineers and capitalists to a country which is deserving of their consideration. Next to Japan, there is no other country of Asia or no portion of Asia that is making more advancement. With an area of 250,000 square miles, a population of 10,000,000, and a foreign trade of $25,000,000, it is entering upon a period of progress and prosperity unprecedented in its history or in that of any Asiatic land aside from Japan. Led by a king, who in some respects is the ablest statesman in Asia, and advised by picked men taken from the councils of European governments, it is making a strong effort for recognition throughout the world as a country of importance and influence in both commerce and politics. It has great staple products to sell, and it has a large buying capacity. It needs extended railway construction throughout the interior, the improvement of its waterways, rivers, and canals, all of which are being planned by the present government. Bangkok, the capital city, with a population of half a million, has already electric lights, electric street-car lines, telephones, and telegraphs; but it wants a system of sanitation and of waterworks.

It has been my purpose in this article to show the greatness of the Chinese or Asiatic field of commerce and exploitation in order to prove more conclusively the necessity of America, England, and Germany working together for the permanent maintainance of the open door. If China was not worth such attention upon the part of these three great powers, there would be no reason for supporting such a policy. The greater portion of this article could, therefore, be considered as devoted to the premises from which the conclusions are drawn. It should be demonstrated by what has been said, that there is in China a field which is worthy of the best efforts in friendly competition of England, Germany, and America to control or share. There is no valid reason why the manufacturers and exporters of these countries, each recognizing the strength of the others, should not unite in urging their respective governments to protect the great markets into which they are entering with so much earnestness, and to which they look with such hopes for the future. Each country is confident of its power to compete with the others where there is a fair field and no favor. Therefore, there is every reason why they should unite to prevent a divided field and open discrimination. There is abundant room for all. Wherever these three great powers, the chief industrial nations of the world, will unite to maintain the open door, or freedom of trade, with equal privileges to all, there will be found an ideal condition which will suit the producers of all three nations.

There is need of immediate action in Peking. In another six months or a year, it may be too late. The tendency is all towards "spheres of influence," which are no less than sugar-coated diplomatic terms for "areas of eventual actual sovereignty." Unfortunately, Germany and England are, in a measure, committed to the principle of spheres of influence. Germany, by her occupation of Kaichau and the extension of preferential concessions through Shantung, and England, by her position in the Yangtze Valley and her recent agreement with Russia, have taken a position which is hardly consistent with freedom of trade and rights to all countries. America, therefore, stands to-day as the one great power which has not yielded to the temptation of the hour and acknowledged, by formal or informal act, the right of any power to a sphere of influence. She is, in other words, the arbiter of China's future. Were she to take the steps already taken by every other important nation, China would go to pieces like an arch from which the keystone had been withdrawn. If now the United States is strong enough in influence and example to hold Germany, Great Britain, and Japan with her in her avowed policy of maintaining the integrity of the Empire and the spirit and letter of the Tien Tsin treaties, she will not only have accomplished for herself the greatest good, but immeasurable benefits for the other powers concerned. This is a position of splendid leadership which the government and people of the United States should appreciate. It should inspire the President to strong, careful action, and the people to support him in what he undertakes.

This leads to my final conclusions. The United States, supported by England, Germany, and possibly by Japan, should stand for the absolute integrity of the present Chinese Empire as known and understood in the treaties; second, for the unrestricted privileges of trade and commerce guaranteed by these same treaties; third, reforms in the government of China which shall not only enable her to govern herself successfully, but protect the interests of foreigners and foreign nations throughout her limits; but, fourth—in the event that the break-up of China seems inevitable, and neither the United States nor any other government stands ready to prevent the division—for the maintainance of the open door in the various spheres of influence, or the same privileges of trade throughout China divided that existed when she was intact.

We must be practical in looking at the situation. The United States cannot afford to stand blindly for the preservation of China as an independent empire, unless they are willing to go to war. It is plain that the American people would not support such a policy as that. Therefore, they must exercise, in connection with other nations, their moral influence to the last degree.

The chief danger is often described as coming from Russia. And Manchuria is now considered essentially Russian. Russia cannot be blamed if she endeavors to build up a market within her own domain for her own manufactories, but other countries, if they would properly guard their respective interests, must see that those markets are kept open to them, without favor or discrimination, which are guaranteed by the old Chinese treaties.

If America, England and Germany will exert in unison the influence which each individually possesses, there will be no question as to the success of their policy. Once seeing that these three powers are in earnest, Russia and France will be compelled to join them without thought or suggestion of war.

Would that some strong guiding hand could direct the relations of these three powers so that they would take the necessary steps before it is too late! What ozone would be breathed into the political atmosphere of Peking if it was definitely announced that America, England, and Germany, followed by Japan, were determined to maintain the integrity of the empire and the spirit and letter of the Tien Tsin treaties throughout all China, from the old boundary lines in the south to those in the north, without reference to alleged spheres of influence, and that China herself must reciprocate their interest in her welfare by instituting the reforms in her government which are so needed and pressing! Hardly would the announcement go up and down Legation Street before Russia and France would see the futility of opposition and echo the sentiment with the same strong force with which it was first announced. Peking politics are in as bad a state as her awful streets, with their mud holes and deceptive hollows. The conditions are as jarring to justice and right as the jolting of her famous carts is to the nerves of the occupant.

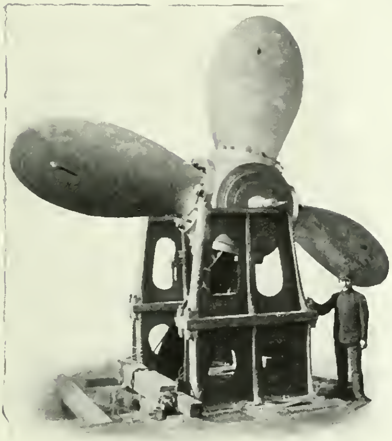
If now America, England, and Germany will come forward and rescue not only China, but their own interests, from the impending disaster, they will perform a duty, not only to the millions of China and to themselves, but to all the world. If they will stand as allies for the open door, the door will never be closed. The future of China as a nation, as a market for their products and a field for their legitimate exploitation, depends upon their united efforts.

It is possible that America alone, were she ready to meet the responsibility, could determine the future of China, preserve the Empire from division, enjoy permanently the privileges of the Tien Tsin treaties, and compel the inauguration of reforms; but political conditions in the United States would never support the government in shouldering this responsibility. On the other hand, if the people of the United States are convinced that by joining forces with England, Germany, and all other powers having like interests, their field of commercial expansion can be protected and enlarged, without war but with the simple exercise of moral pressure, they will support the government in such a policy.

THE DEVELOPMENT OF GERMAN SHIP-BUILDING.

By Rudolph Haack.

III.—THE SHIP YARDS ON THE BALTIC.



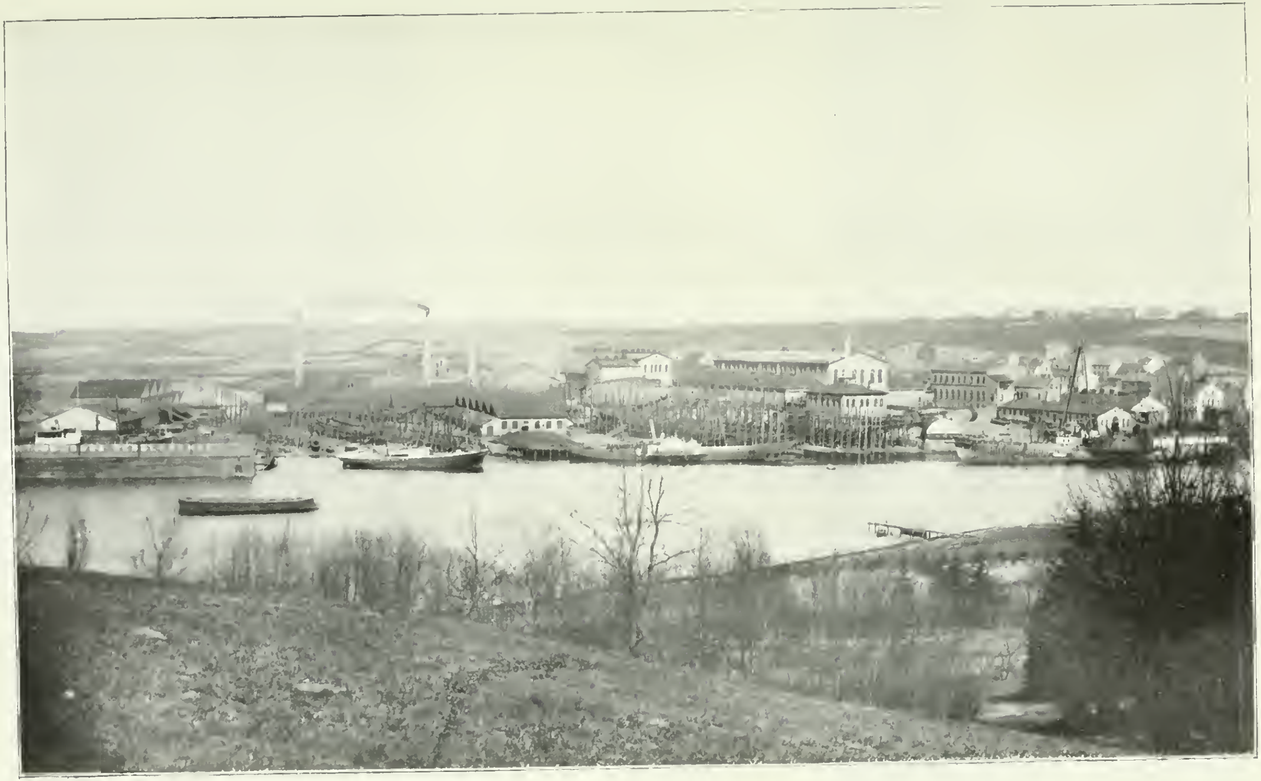
THE last article enumerated all the yards on the North-Sea coast, and we now begin in the Baltic with the yard of the Flensburger Schiffbau Company, in the harbor of Flensburg on the north coast of Schleswig. This yard and the machine shops are new, started by citizens of Flensburg in 1872, and from the very start always increasingly active. Mr. Bredsdorff is manager of the ship-building department, and Mr. Bauer manager of the machine shops. The chief business of the firm is to build passenger steamers and freighters, especially large sea-going steamers of 4,000 to 8,000 tons; but it builds vessels also for the Baltic and North-Sea trade, especially for the lumber trade, and also large sailing vessels as well as smaller vessels of all kinds. The fact that in 1890 the output was 14,196 gross tons with 6,915 i.h.p., and in 1897, 29,357 gross tons with 12,620 i.h.p. shows the tremendous forward spurt of this firm in recent years. It has constantly earned good profits—a sure indication of favourable situation and intelligent management. This is also proved by the yearly turnover, which last year amounted to 7,000,000 Mk., and by the dividends which have been 8 per cent. to 10 per cent., and in the year 1890-91 reached 18 per cent.

A steady supply of work of one kind does not require relatively so large a number of engineers, officials, and foremen as are needed in yards whose business is more diversified. In the Flensburg yard there are only eight naval constructors, seven mechanical engineers, and thirty-eight officials and foremen. The increase in the number of workmen on the pay roll is as follows: In the ship-building department, in the fiscal year 1890-91 seven hundred and twenty-nine, but in 1897-98, one thousand three hundred and ninety-seven. In the machine shops, three hundred and fifty in 1890-91 and four hundred and seventy-three in 1897-98--from which figures the advance in importance can be judged.

War vessels have not been built at Flensburg; but on foreign orders twenty-two merchant ships, with a total gross tonnage of 25,320 and 12,110 i.h.p. and, for the same trade, three self-trimming dumping barges and one steamer of 5,900 gross tons and 2,500 i.h.p. are now on the ways. In addition to the above-mentioned kinds of ships, the firm also executed such cognate orders as floating cranes, ice-breakers, floating docks and, as a specialty, the Clark and Stanfield off-shore docks, of which the firm owns one at its own yard, using it for repair work.

The active enterprise of the firm is further shown by the fact that a recent purchase has been made adding 27 acres to the existing 11 acres area of the yards, and by this addition it can realise plans already formed for a very material increase in the size of the establishment. Among all the many ship-yards of Germany, there is scarcely one to be found which surpasses the Flensburg yards in steady, conservative, yet rapid development and increase.

The North German ship-yards of Kiel had been active for many years and had completed a number of war and merchant vessels when, in 1879, it was taken over by the ship and engine-building joint-stock company "Germania," which also and at the same time took over the going engine works of F. A. Egells, which had been started in Berlin in 1825. When work on the Prussian navy was first begun this firm supplied many engines for the wooden gunboats already mentioned, and as orders increased for large engines for the navy, the whole establishment, which had become a joint-stock company, was moved from Chaussee Street, Berlin, to Tegel near Berlin, where great work-shops for engines and boilers were planned and built. Here many of the engines were made for these vessels, built partly before 1879 in the North German ship-yards and later in the yards of the new company. It was found, however, that the great distance between the two departments, (ship-building yards and engine works) had many disadvantages, especially in winter when ice hindered seriously the carriage of boilers and other heavy pieces. This, as well as insufficiency of working capital, was the chief reason for the company's lack of prosperity, and led the shareholders to consent to the sale of the works to Friederich Krupp of Essen in 1896.



GENERAL VIEW OF THE KIEL SHIP-YARDS IN 1885.

STETTINER LLOYD STEAMER MARTHA.

1,000 i. h. p.; built at the Kiel ship-yards in 1884.

New life was thus infused into the establishment, and this first showed itself by plans for the removal of engine works and machine shops at Kiel. The works at Tegel covered 15 acres, while the new works at Kiel have an area of nearly 22 acres and the area of the ship-yards has been increased from 14 to 34 acres.

Notwithstanding the change of ownership and location, the old managers—Mr. Schulz for engine works and Marine-Oberbaurath Rauchfuss for ship building—have held their positions. The former has under him fifty-three, the latter forty-seven, engineers busy with designs, plans, estimates, and the oversight of the work. In the work-shops and in the yards there are eight overseers and forty-six fore-men, responsible for accurate work, and in the office there are sixty-seven employees. In 1890 there were six hundred and seventy-six workmen on the pay roll in the engine works and in 1898 this number had increased to one thousand one hundred and sixty. In the ship-yards the increase was from nine hundred and ninety-six to one thousand three hundred and one, so that the total number of work-men on pay roll at the beginning of this year was two thousand four hundred and sixty-one.

These yards, since their establishment, have built for the imperial German navy ten battle-ships, among them the ironclad of the first class "Wörth," the protected cruisers "Kaiserin Augusta," and "Princess Wilhelm," as well as the engines for several vessels built in the Imperial navy yards. For foreign sea-powers the firm has built three large ships and sixty-five torpedo boats and torpedo-boat destroyers, twenty-seven merchant steamers of various kinds and sizes, and four steamers for the African colonies.

At the beginning of the year there were on the ways one first-class battle-ship, three cruisers, one torpedo-cruiser, three torpedo boats, and one racing yacht.

In addition to ship-building the firm also built steam dredges, dock gates and locks, racing yachts, mining machinery, steam pumps, hydraulic plants, stationary engines, etc.

In 1838 Mr. A. F. Howaldt started, in Kiel, machine shops which were later taken over by the firm "Schweffel and Howaldt," and at a comparatively early date marine engines were built; the sons of the original owners of this concern added (in 1865 at the same place) yards for iron ships, and later, under the firm name of "Howaldtswerke," the whole establisment was entirely rebuilt on yards of 9 acres extent at Dietrichsdorf at Kiel, engine works being added.

The yards are under the management of the brothers Howaldt and have rapidly increased, being principally busy with freighters and passenger steamers of all kinds, among them, and the largest, a vessel 390 ft. long, 55 ft. beam, and 25 ft. 9 in. hold. The firm builds also sailing vessels, dredges, boilers, railway supplies, steel and bronze castings, and forgings of large size.

TOWING AND WRECKING STEAMER KÖNIGSBERG.

42.89 tons, 100 i. h. p. Capacity of wrecking pumps, 4,750 gals. per minute.
Built by Howaldtswerke, Kiel, in 1896, for the Imperial canals.

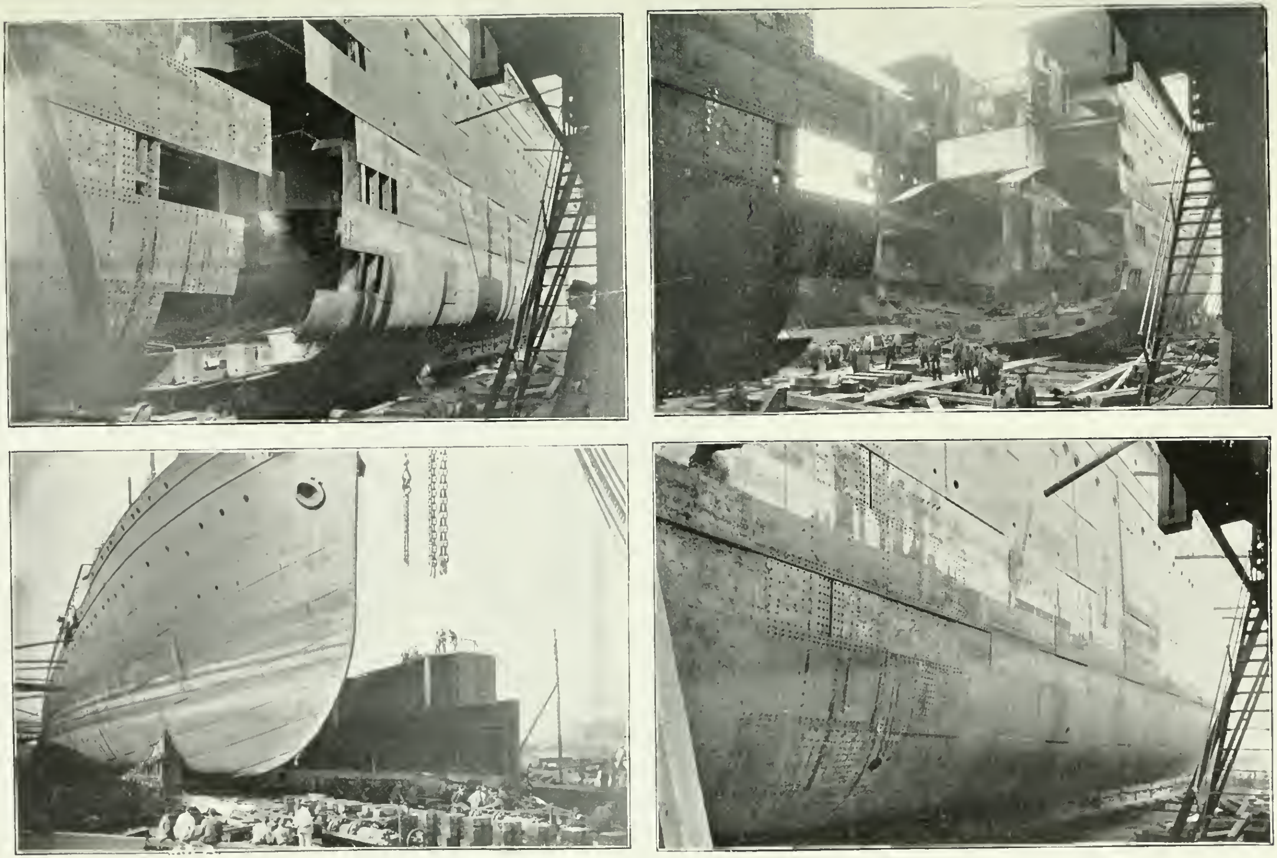
The following figures are proof of rapid advance in comparatively a short time: Ships delivered in 1890 gross tons, 10,331, with 5,227 i.h.p.; in 1898, 16,375, with 9,115 i.h.p. The total turnover in the working year 1897-8 was 5,700,000 Mk. In the offices and shops are ten naval constructors, eighteen mechanical engineers, and sixty-two officials and foremen. In 1890, the average of workmen employed was one thousand four hundred and sixty-nine and in 1898 this had increased to two thousand three hundred and twenty-seven. Two floating docks, each of 3,200 tons lifting capacity, and a third, now building, of 3,500 tons, are used for repairs, for which (owing to the constant increase of shipping through the North-Sea-Baltic canal), there is always large demand. The management have also made special and persistent efforts to secure foreign orders. They have sold ships to Russian, Swedish, French, Danish, Roumanian and Honduras customers, and their enterprise and activity will cause the Howaldtswerke to grow still further.

There are still two very small yards for wooden ships in the bay of Kiel, that of Scharstein in Dietrichsdorf and the other of G. Krüger, in Seedorf. The former builds pleasure yachts, the latter small sail-boats.

The next big establishment for large iron vessels, that of the firm Henry Koch in Lübeck, whose title mentions its location, was founded in 1882-83 and is still carried on by the heirs of the founder—the brothers Koch. The work done in 1897 had a value of 2,500,000 Mk.; the vessels registered 32,451 gross tons and their engines were of 1,250 i.h.p. At the beginning of the year eight vessels of

IMPERIAL GERMAN MAIL STEAMER PRINZ ADALBERT.

253 tons net. Two triple-expansion engines of 1,250 i. h. p. total Speed. 15 knots. Built at Howaldtswerke. Kiel.



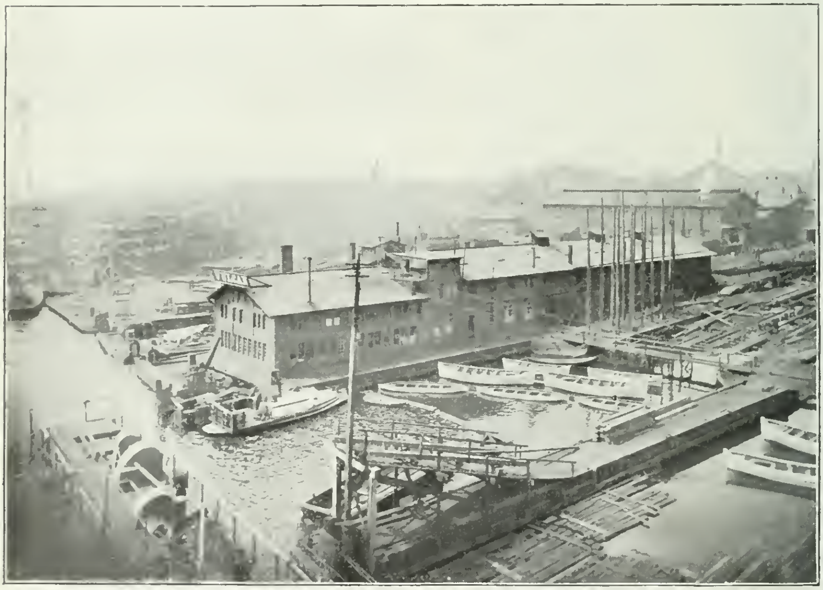
View at 6 meters extension.
The bow, showing the ways and hydraulic motors.

View at completion, 20 meters extension.
View at the start. The rivets cut away.

FOUR STAGES IN THE LENGTHENING OF THE SPREE—NOW THE KAISERIN MARIA THERESIA—AT THE VULCAN WORKS, STETTIN.

9,350 gross registry and 3,350 i.h.p. were on the ways. Eight engineers, twenty-five foremen and officials, and five hundred to five hundred and twenty workmen are actually employed. The area of the yards is nearly 10 acres and in front of the yards are two floating docks for repair work; owing to the growth of shipping at Lübeck these are often in use. For a long time this firm was short of orders, but more recently has been fully employed with profitable contracts, and this speaks well for growing confidence and satisfactory results.

One of the oldest of the German yards for iron vessels is the Aktien-Gesellschaft "Neptun" in Rostock. This was started in the fifties by the engineer Tischbein, and from the start iron steamers were built of a tonnage then considered large, but no profit was made owing to the lack both of experience and of competent workmen. There was no improvement when the establishment was taken over by a joint-stock company and its area increased by the purchase of adjacent land, nor until finally, after many changes of management, the whole concern was taken over by the present joint-stock company "Neptun."



THE VULCAN WORKS, STETTIN. PANORAMA COMPLETED ON OPPOSITE PAGE.

In 1890 the yards turned out a total gross tonnage of only 9,000, with 2,300 i.h.p.; but in 1897 this had grown to 18,600 gross tons with

5,300 i.h.p., with a turnover of 2,960,000 Mk. Seven hundred and sixty workmen were employed in 1890 and this number increased gradually to eleven hundred in 1898. The directors, Barg and Knappe, manage the whole business and have on their staff five naval constructors, twelve mechanical engineers, twelve commercial employees and eighteen foremen. The yards were almost entirely reconstructed in 1894, provided with good modern machines and apparatus, and the whole plant now covers an area of 22 acres.

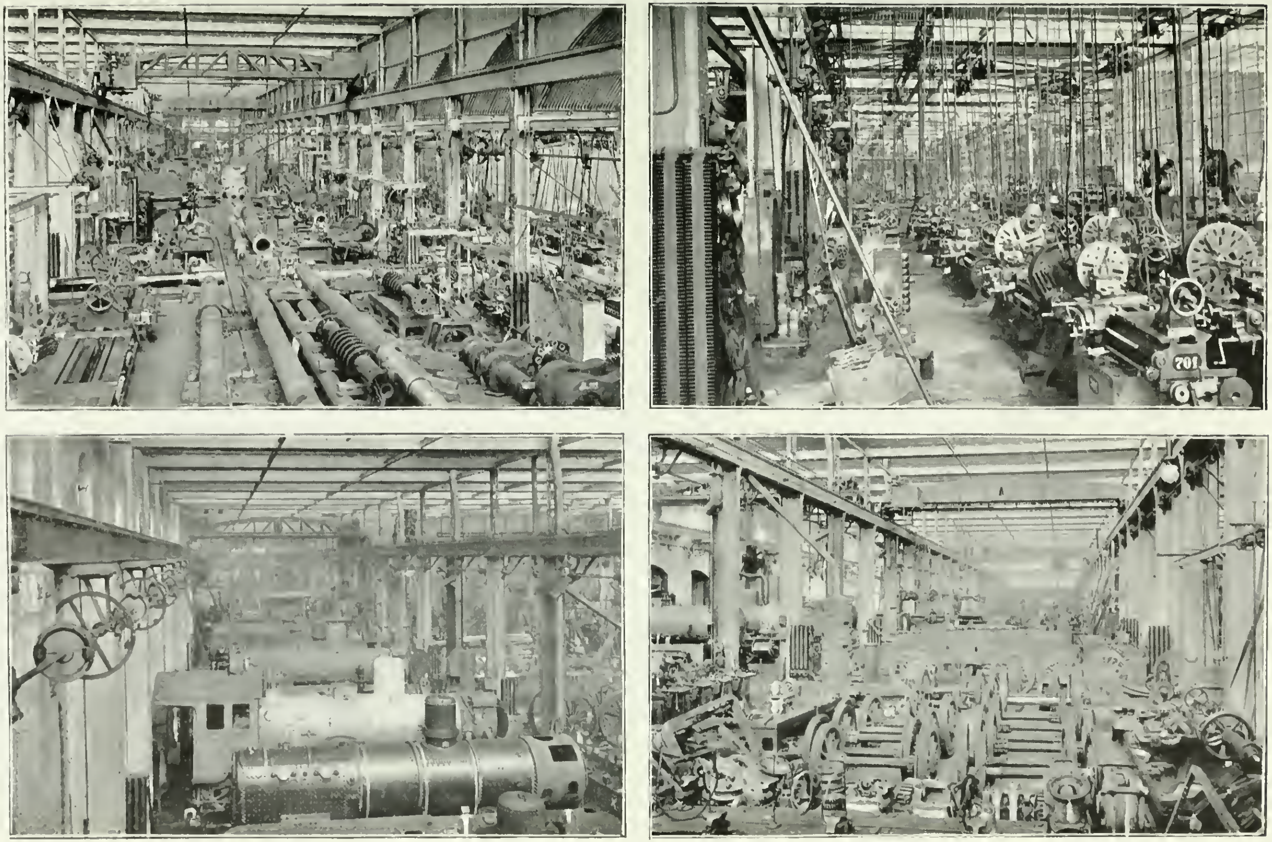
In addition to ships for German registry the "Neptun" built merchant steamers for Sweden and Russia and, as its appliances are large enough for vessels even of 10,000 tons and wages are comparatively low, it will have plenty to do under normal conditions. For repair work the very insignificant shipping interests of Rostock are not very favourable. Larger vessels occasionally come from other harbours, and for such repair work there is a marine railway and special workshops.

THE VULCAN WORKS, STETTIN. COMPLETING THE VIEW SHOWN ON PAGE 18.

From Rostock to Stettin there are a few scattered and small yards—as at Barth, Stralsund, etc.—building wooden ships.

We now come to the largest and most important private shipyard in Germany, which also has played the most important part in

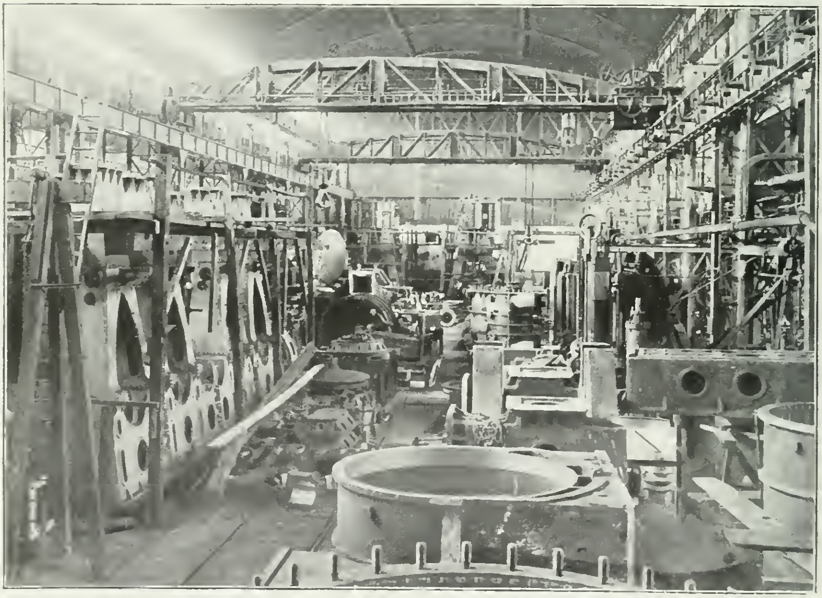
GLIMPSES OF THE VULCAN BOILER SHOPS, AT STETTIN.



FOUR BAYS IN THE LOCOMOTIVE AND LATHE SHOPS AT STETTIN.

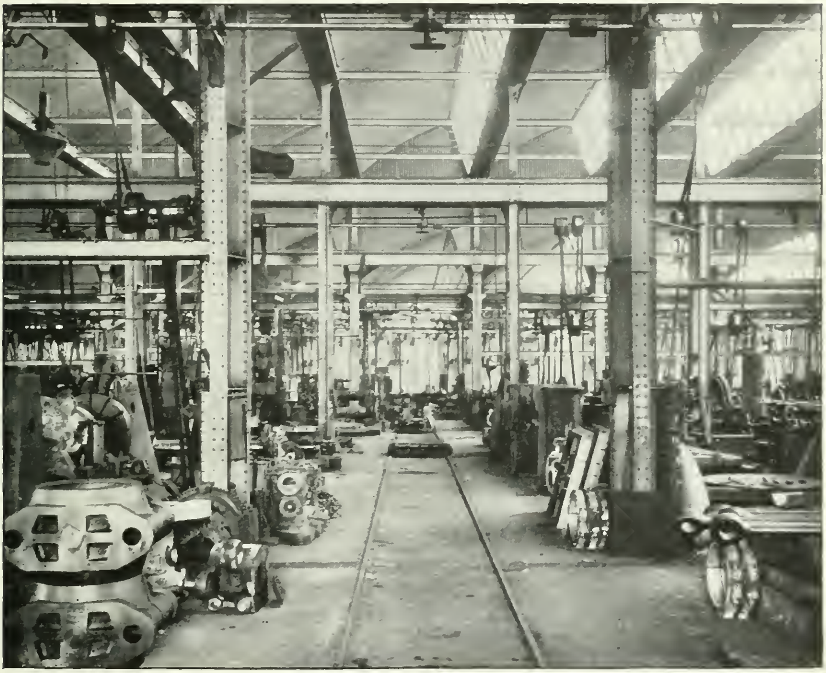
the development of German ship-building. It is the Stettiner Maschinenbau-Aktien-Gesellschaft "Vulcan" in Bredow-Stettin. Two engineers, born in Hamburg, but trained at Berlin in the engine works of Wöhlert (which have long since gone out of existence) founded in 1851, under the firm name of "Früchtenicht und Brock," a little yard and machine shop at Bredow, in which they planned to make machines of all kinds. In the yard they began the construction of a little side-wheel passenger steamer "Die Dievenow," which began in 1852 to make trips on the lower Oder, and was so well built that she is still running. As early as 1855 the contract was taken to build for a Stettin firm three sister screw steamers, of dimensions at that early date considered large; but the shops were not equal to the task. They had neither engineers, designers, workmen, nor tools, nor were they provided with the necessary capital to increase their plant, which was therefore taken over by the present joint-stock company.

But for a long time this new concern met with no success. There were no orders, and therefore lack of steady work; nor did engine building prove profitable, although, to increase it, tools were secured for the building of locomotives for which, however, at that time there was very little demand. But the beginnings of German railroad



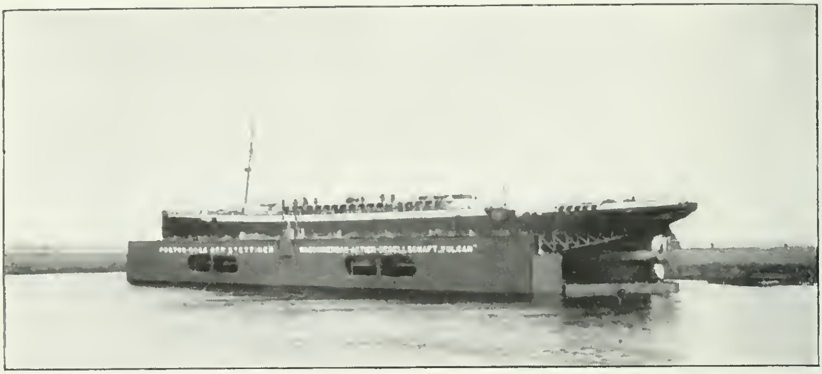
PART OF THE VULCAN ERECTING SHOP.

development at about that date soon stimulated a demand for locomotives, and this exceeded in value the demand for ships, and, as skill was acquired, some money was made and the profit from this source more than once was of exceeding use in tiding over financial difficulties. But ship-building lagged, notwithstanding improvement in design and construction. Contracts were only secured on small margins until, after the successful ending of the war of 1871, a contract was accepted to build the iron-clad frigate "Preussen," against the advice of those most competent and even against the advice of the chief constructor of the Imperial navy. Instantly everything changed favourably and ship-building began to be more and more profitable, especially as big orders poured in for men-of-war for Germany, and for China and other foreign sea powers.



LATHE SHOP, VULCAN WORKS.

As the years rolled by there was once more trouble, and this was when the delivery of the six Imperial mail steamers in 1887 did not seem *a priori* to promise any very satisfactory result. It became manifest, however, not only that these steamers had caused no



THE KAISERIN MARIA THERESIA IN FLOATING DRY DOCK AT STETTIN.

trouble, but that their excellent construction had proved that the "Vulcan" was quite as competent to contract for ships of this kind as any British yard, and it thus earned for itself in particular, and for German ship-building in general, the confidence of the strongest shipping firms. It soon secured the contract for the first fast passenger steamers of the Hamburg company and the North German Lloyd, and these were followed by other contracts, so that the company was soon able to pay good dividends to its shareholders, although in this direction the building of locomotives had brought about considerable improvement at an earlier date.

Up to the present time, the "Vulcan" works have built, including the ships still on the ways, sixty-one large and small war vessels and one hundred and thirty-seven large screw steamers for the merchant service and forty-nine side-wheel steamers of various types.

With this great increase in the activity of the plant in its several branches it has been necessary several times to rebuild shops and renew equipment, and at the present time it has attained a high degree of perfection in its many departments. The various illustrations give a better idea than written description. It may, however, be mentioned that the plant at present covers an area of more than 61 acres.

The increase in ship-building activity is best indicated by figures:

1851	Ships	102	Gross reg. tons.	Engines	200 i.h.p.
*1857	Ships	2,648	Gross reg. tons.	Engines	3,820 i.h.p.
1890	Ships	14,207	Gross reg. tons.	Engines	25,600 i.h.p.
1896	Ships	20,390	Displacement.	Engines	44,000 i.h.p.
1898	Ships	71,600	Gross reg. tons.	Engines	174,000 i.h.p.

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* This was the year of incorporation as a joint stock company.

This includes ships still on the ways at the beginning of 1899. The turnover in 1897 was, in round numbers 20,000,000 Mk.

In this tonnage eleven large war ships are included, of which two are not yet finished, amounting in all to a displacement of 50,000 tons and about 90,000 i.h.p.; twenty-three torpedo boats with 1,400 tons displacement and 17,000 i.h.p., and twenty-seven large and small merchant steamers of 15,000 tons displacement and about 16,500 i.h.p., which were ordered by foreign governments and firms.

The locomotive department turns out about one hundred locomotives annually.

The present managers are Messrs. Stahl, Zimmerman and Flohr, assisted by a staff of seventy-four naval constructors, seventy-eight mechanical engineeers, one hundred and seven office staff and other officials, and one hundred and seven foremen.

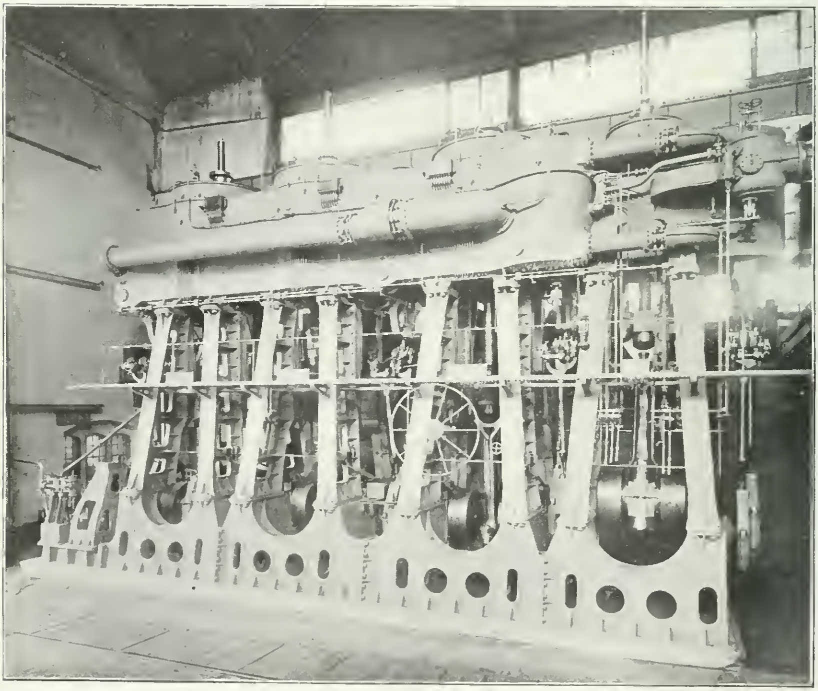
In the year 1890 four thousand seven hundred and seventy workmen were employed, and in 1897, five thousand seven hundred.

Everything connected with the building or repair of ships and vessels of every kind—dredges, floating cranes, and all similar work—is undertaken by the "Vulcan" and completed almost wholly in its own plant. As part of the equipment there are two floating docks of iron, the largest with a lifting capacity of 12,000 tons. The largest vessel now building, or ever built in Germany, is the already mentioned Deutschland for the Hamburg-American Company. Its dimensions are 662 ft. 9 in. between perpendiculars; its greatest beam 67 ft., and it is equipped with two quadruple expansion engines, each of 16,500 i.h.p., a total of 33,000 I.H.P. The dimensions of each engine are:

2 High-pressure cylinders.....	36.6 in.	(930 mm.)	diameter.
1st Intermediate cylinder.....	73.6 in.	(1,870 mm.)	diameter.
2nd Intermediate cylinder.....	104.0 in.	(2,640 mm.)	diameter.
2 Low-pressure cylinders.....	106.2 in.	(2,700 mm.)	diameter.
Piston stroke	73.0 in.	(1,850 mm.)	

SHIPPING AT THE ODERWERKE, STETTIN.

The size and capacity of the "Vulcan" place it at the head of all German ship-building plants and make it equal to the largest of other countries' plants. In its offices and shops the final touches have been given to the training of a great number of engineers and many of them are to-day managers of other works. In addition, many workmen have learned their trade in the "Vulcan" works, and are either still working there or have found good paying jobs in the Imperial and private yards. Also the well-known extraordinary performances of the "Kaiser Wilhelm," built in the "Vulcan" yards, have given to German ship-building a name and fame which has spread far and wide and is unsurpassed by that of any other land.



FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE KAISER WILHELM DER GROSSE.

27,000 i. h. p. Schlick counterbalancing system.

Another yard in Stettin has recently worked itself to the front. It is the Aktien-Gesellschaft "Oderwerke," Maschinenfabrik und Schiffswerft, of Grabow near Stettin. This was originally a little plant founded under the name "Stettiner Eisengiesserei" in 1837; it gradually grew and was finally taken in hand by Messrs. Möller and

Holberg. These soon added ship-building to the other work, bought out other neighboring plants and yards, and sold the whole again to a joint-stock company whose success was not what the shareholders expected. The whole plant, therefore, passed by sale to the above-named company, which increased its capacity and facilities by new buildings, tools, shops, floating docks, etc., and it continued to manufacture in a number of other lines besides ship-building, which therefore developed but slowly.

THE KAISER WILHELM DER GROSSE LEAVING SWINEMÜNDE, SEPTEMBER 14, 1897.

In 1889-90 steamers were built engined with 3,635 i.h.p.; by 1897-98 the engine output increased to 5,000 i.h.p., and last year the cash turnover was 3,330,000 Mk.

The present managers are Messrs. Annell, Blackstady, Heumann and Fink; the staff includes ten naval constructors and twenty-three mechanical engineers, as well as eighty other employees; the number of workmen varied, between 1889 and 1898, from one thousand to one thousand nine hundred and the yard covers an area of 34½ acres.

In addition to ship-building, the company builds stationary engines, sugar machinery, brick-making machinery, and undertakes repairs of every kind for these specialties as well as for other machinery and ships. Up to the present the company has sold abroad twenty-three merchant steamers, of a total of 9,075 gross tons burden with engines of 7,105 i.h.p. The largest steamers as yet built do not exceed 1,300 tons burden; the largest iron sailing vessels are of 2,400 tons and the largest engines are of 1,100 i.h.p. The equipment and area of the yards ought to permit a large increase in these sizes.

This company has made its greatest progress in the last few years, so that further favourable growth and increased earnings are to be expected.

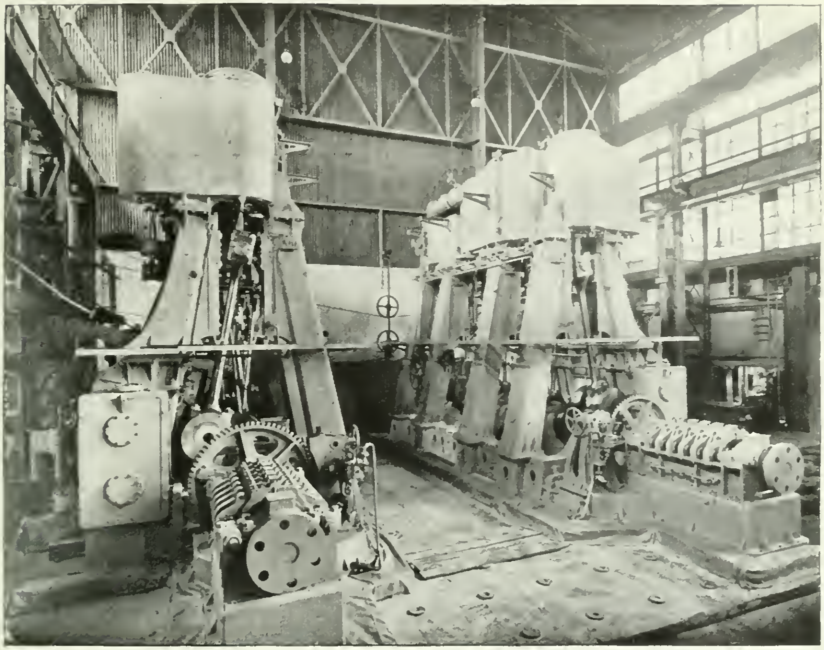
In 1890, at Grabow near Stettin, Messrs. Joh. Nüscke and O. C. Peuss established a yard for the building of iron passenger steamers and freighters. This yard had built wooden ships as early as 1815, and then fallen to the condition of a repair yard; but now, since the above firm have taken hold, it has advanced from a delivery of iron ships of a total of 250 gross tons register and 250 i.h.p. in the first year, to 3,490 gross tons in 1897-98, with 1,940 i.h.p., and a yearly turnover of 1,000,000 Mk., in which are included very numerous and important repairs.

Under the management of the owners are seven engineers and three hundred and twenty workmen, although the latter only numbered seventy-five in 1890.

The yards and plant cover an area of nearly 3 acres, and the little engine works build not only marine engines, but also engines for farm use and for drying purposes. Ships needing repairs are placed either in the floating dry-dock or drawn out of the water on the moving ways. Last year Stettin was made a great free port and the consequent increase of shipping interests at Stettin promises for these yards growth and prosperity.

In addition to the Imperial navy yards, there are four private yards in Danzig in which vessels of iron and steel are built. The first of these dates back in its beginning to the last century, and is that of I. W. Klawitter in Danzig, of which place the oldest ship-builder of this name was a native in the year 1589. Great activity was developed here in the building of wooden ships, and many sailing vessels of all kinds were built before 1877. In 1855 the first corvette of the Prussian navy was also built here, the engines coming from England. This was followed by orders for a number of wooden gun-boats, with German engines, and the owners also began as early as 1853 to build iron cargo boats of about 500 tons burden, with engines of 250 i.h.p.

From 1875 on the works were completely re-equipped for the



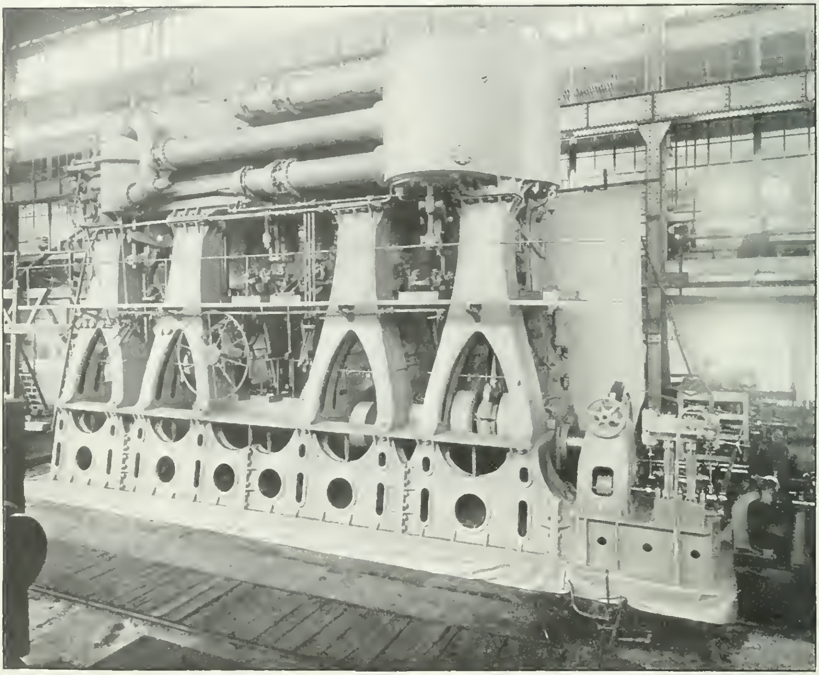
FOUR-CYLINDER QUADRUPLE-EXPANSION ENGINES OF 5,000 I. H. P.
Built at Stettin in 1898-99 for the Hamburg-American steamer Patricia.

building of iron and steel vessels, and engine works and boiler shop added to the plant. Up to 1897, the firm delivered thirty-six boats such as steam dredges, barges, barrack and fire boats, etc.

Conditions of navigation on the Vistula make it essential that there shall be great power and very little draft in the boats going up and down this river, and the firm was very successful in solving this problem, so that they received a number of orders for boats of similar design. In addition, the firm sent out freighters up to 200 tons with engines of 1,500 i.h.p.

The firm owns an old wooden floating dock, dating from 1850, in which the very first Prussian war vessels were docked before there were any better government facilities, and this is now used to take vessels out of the water for repairs. Besides this antiquated dock, the yard is equipped with two marine railways of best modern design. The area of the yards is about 9 acres and under the management of Mr. Klawitter there is a staff of fifteen engineers, thirty foremen and salaried employees, and on the pay roll about seven hundred workmen.

A second concern, started quite early, in the old sea port of Danzig, is the firm of Danziger Schiffswerft und Maschinenbauanstalt Johannsen and Co., which was founded in 1856 by F. Behrends and Devrient and until 1869 was occupied only with the building of wooden sailing vessels. At this date the building of iron ships was begun, but nothing of importance done until, in 1890, the old firm was taken over by the new concern above named. The business is now carried on with a staff of five officials and one hundred and twenty workmen; it delivered, in 1897, 600 registered tons, of which one ship was of 200 ft. length and about 670 i.h.p., and it executed some foreign orders in addition. It builds also dredges and barges, and undertakes repairs for all kinds of shipping, for which purpose there is a marine railway. The whole plant covers an area of about 3½ acres.

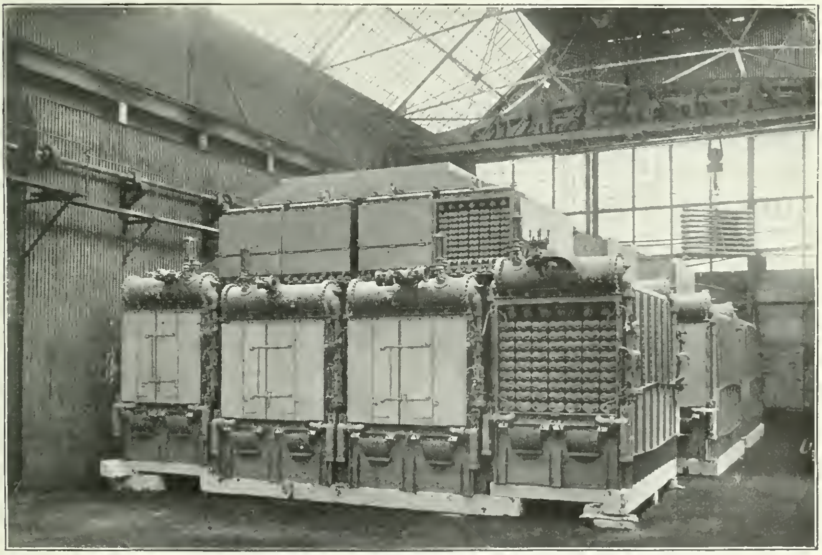


FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE KAISERIN MARIA THERESIA.

16 000 i. h. p. Schlick counterbalancing system. Built at the Vulcan works, 1898-99.

A larger yard than this one, owned by the firm H. Merten, Ges. m. b. Haftung, was also located at Danzig in 1878; it builds iron freighters, passenger steamers, and steam tug-boats up to a length of 200 ft. Larger engines are purchased from other firms, the machine shop only building sizes up to 48 i.h.p. At present there is a staff of twelve engineers, who direct three hundred and sixteen workmen; and in 1898 eighteen little vessels of a total tonnage of 948 gross tons were built. The area of these yards is nearly 5 acres.

By far the largest yards in Danzig are those of the firm F. Schichau, and they are indeed among the largest in all Germany and were established in 1891 by the Maschinenfabrik und Schiffswerft F. Schichau, in Elbing, for the building of big vessels, for which water depth and other conditions were not favourable on the Elbing river. The eminent Kommerzienrath F. Schichau, who died a few years ago, was the founder of these works and German industry owes him a great debt of gratitude. He started in 1837 with a little plant in Elbing for general machine work and engine building, and soon took up little boats, dredges, etc. As early as 1855 a screw steamer was built, which for many years plied on the Baltic. Towards the end of the seventies he began to build torpedo-boats for Russia, and later, when the German navy wanted these in great number, owing to his experience those built by Schichau were for a long time preferred to others. Very recently a few other firms—the Germania in Kiel for instance—have



BELLEVILLE WATER-TUBE BOILERS FOR JAPANESE CRUISER YAKUMO.

43,400 sq. ft. heating surface and 1,210 sq. ft. grate surface. Built at the Vulcan works received torpedo-boat orders, but the greatest number still come from Elbing. It was also quite in order that many foreign powers should make use of the very great experience of these Schichau yards in this particular, and therefore orders in great number were received for torpedo-boats and torpedo-boat destroyers, and so the deliveries for both yards, at Danzig and Elbing, amounted last year to 667, nearly all of them torpedo-boats. It is only since the equipment of the yards in Danzig that orders have been taken for the largest vessels, and among them battle ships for the German and Russian navies, great passenger steamers and freighters for the North German Lloyd of Bremen, etc.

The machine shops at Elbing not only delivered the torpedo-boats, etc., but also all the engines for all vessels built there and has besides built, since its organisation, about one thousand locomotives and many stationary engines; its fame extends far beyond German borders.

Further east towards Königsberg, where formerly wooden-ship building flourished, there is still a yard dating from that time—that of Gustav Fechter—which undertakes to build little iron ships, but is now doing very little.

The firm Memler Maschinen und Schiffbau Giesserei und Kesselschmiede, Kroll & Eulert, in Memel, is doing some work under conditions somewhat more favourable. It builds little cargo boats and passenger steamers of every kind, of which in 1898 it delivered 370 gross tons. In 1897 the turn over was 200,000 Mk., employment being given to two engineers and from one hundred and forty to two hundred workmen in yards with an area of 3 acres.

STANDARDISING IN ENGINEERING CONSTRUCTION.

By Sir Benjamin C. Browne.

I.—ECONOMY OF TIME, LABOUR, AND EXPENSE IN WORKING TO STANDARD TYPES.

A CONSIDERABLE amount of attention has been lately drawn to the number of orders for engineering plant and material which have gone from Great Britain to the United States, and it would appear that both our manufacturers and the public generally are seriously concerned at the large volume of work that has left the country. Many reasons have been brought forward to explain the case, and to show wherein the Americans have advantages over us. Some of these may be due to natural causes, but some are probably due to their better system, or greater business aptitude.

One point on which I now wish to dwell is the fact that they apparently work, much more thoroughly than we do, to standard types and specialties. It is, of course, a question which admits of no absolute solution how far it is better to use what may be called "ready-made" articles, and how far to have articles specially made for the purpose; but, in the case of some of the orders that have gone past us, there is a great deal to indicate that if the English worked more to standard patterns they would have secured some, at any rate, of the orders which have now gone across the Atlantic. It is, of course, by no means altogether the fault of the manufacturers, and I shall have a good deal to say as to how far the purchasers, their professional advisers, and the consulting engineers of the country generally are responsible for this state of affairs.

There are three points which I specially wish to look at as illustrations from this point of view. First, that the Egyptian authorities placed with the Americans an order for a bridge, for the Soudanese Railway over the Atbara River, on account of getting very much quicker delivery than they could get in this country. Second, certain railways, especially the Midland and the Great Northern, have given large locomotive orders to America, and thirdly, an ever increasing number of machine tools, especially for engineering work, come from the States. We may also add that the electrical plant that is used in this country is purchased from America and elsewhere, to an extent that is not only very serious but not creditable to the energy and

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Nothing more clearly indicates the persistence of the qualities which have made Great Britain industrially great than the frank recognition, on the part of manufacturers in every enterprise of the manufacturers. The same applies, in some degree, to agricultural machinery; but this is probably more excusable, as, for obvious reasons, the Americans have great advantages in making and developing this class of work. The remarks I shall make as to machine tools apply also to electrical machinery; but first, as regards the Atbara bridge.

The question has been gone into very thoroughly and some interesting letters have been published by Mr. Sell, in his "Commercial Intelligence"; roughly speaking, the story seems to be this:

That a bridge being wanted in a great hurry to carry the railway over the Atbara River, the engineers, who were responsible, made designs and sent enquiries to seven English firms. Being disappointed in the deliveries that were promised, they then appear to have made enquiries from American firms, and got a promise of a quicker delivery than any English firm could give, and (though this appears to be a matter of minor importance), at a lower price; and they gave the order in the United States. According to Lord Belhaven, the bridge was completed and inspected in America in 27 days.

Now, if it had been the case that the English builders were all full of work, and therefore could not undertake an urgent order, there would be nothing worth discussing; it would merely be an ordinary accident of trade; but Messrs. Westwood & Rigby, who tendered for this bridge, say that they were prepared to put the work in hand at once, that they made special arrangements to have the material rolled immediately, and that, in fact, the question of being busy would not have affected their promised delivery. We are therefore brought face to face with the fact that an American firm was able to build the bridge in less time than any English firm. But now comes another point. It has been generally stated, and not contradicted, that the Egyptian War Office had instructed their engineer to design a bridge and make a specification of a very elaborate character, which was submitted to Messrs. Westwood & Rigby, and presumably to other people. But this specification appears not to have been put before the American firms at all; they were allowed to tender on their own design, and this, of course, would give them an enormous advantage. Suppose that they had recently made a bridge of approximately

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line, of the defects of the present British position. Everywhere there is full acknowledgment of any advantage possessed by rivals, and firm determination to secure and adopt any improvement, in machinery or practice needed to put England on as sound a footing as her sharpest industrial competitor. THE ENGINEERING MAGAZINE rejoices in placing before its readers the conclusions of two leaders of reorganisation so prominent as Sir Benjamin Browne and Mr. J. Slater Lewis, the first of whose papers on Works Management for the Maximum of Production begins on page 59 of this issue. THE EDITORS the same span, and to do the same work (and we may remark that at any given time probably some firm in England or America would be almost sure to be in such a position); they would then have a complete set of drawings, patterns, templates, and everything else; the weight of every part would be known to a nicety, and the men in their employment would all be exactly drilled, each one to take up his position to go on with the work without any delay.

Now, every engineer must know that if you repeat the same process over and over again, and especially if a large number of men are involved therein, the speed at which it can be carried out will be enormously increased, and the last article of any kind out of a large number may easily be made in the same number of days as the first one took weeks to complete. Whether any of the English manufacturers would actually be in the same position as the American firm, of course we do not know; but it seems quite clear that they never had the same opportunity of offering their own design. Very probably the Americans have more demand for large bridges and therefore were more likely to have the exact article "cut and dried."

Probably no rule can be exactly made as to what are the cases in which the engineer for a railway, or for anything else, will act more wisely in preparing his own designs, or in accepting those of the manufacturer. It is sometimes said, that if he is responsible for a design, he ought to make it himself; but this is really fallacious. It is quite clear that if a design, not his own, is submitted to him, he ought to investigate it and see that it is in every way satisfactory; but if he is a qualified man, he should be able to do this if anything more easily than he could make his own design, though, of course, it is not so flattering to his professional pride and does not bring his personality into the same prominence.

Now, where can we draw the line between the point where we ought to use standard designs, and the point where we should begin to use special designs? It is obvious that a large majority of railway bridges cross over roads or railways the width of which varies very little, and as there are probably hundreds, or perhaps thousands, of such bridges constantly being required in the world an engineer will, in most cases, do better to adopt an existing design, which has often been used and of which every possible weakness has been discovered by practical wear and tear, than to design something out of his own head. It will probably be better and certainly far cheaper. If a special bridge is required for an exceptional case, then clearly it is desirable for the best man that can be got to give his very best energy to designing something as perfect as possible, specially suited to the case, the question is: where shall the line be drawn between the two?

There is no doubt a general feeling in the world that English engineers are too fond of their own designs, and too unwilling to adopt those of other people. In an article in *The Engineer* published on the 7th April, it was indicated that the influence of Great George Street, which is the headquarters of English consulting engineering, had injured our locomotive trade most seriously. What applies to locomotives applies also to bridges; and it is rather significant that the two great complaints of work having recently gone to America both of them concern railway work, and are therefore matters for which railway engineers are responsible.

The Engineer in this article went so far as to say that it considered the locomotive trade of England had been seriously injured by the consulting engineers of Great George Street, who would insist on each engine having exactly what they fancied to the smallest detail, so that the locomotive builder had no opportunity of building large numbers of similar engines for a market in the way that is followed by the Baldwin and other American companies. We may probably assume very much the same thing about bridges; at any rate, the two things, in some degree, go hand in hand, and probably no one, who is not in the trade, can realise the very great extent to which energy and enterprise are crippled if a manufacturer is compelled constantly to follow the caprice of one customer after another. and has no opportunity whatever of even classifying and utilising the information that he picks up from experience as he goes along. Of course, on the other hand, it may be argued that the business of the consulting engineer to a railway company is to get the best articles that he can conceive for his clients, and not to consider the general trade of England. This may be so, but our present business is to point out where the trade of the country suffers.

As we get from bridges to smaller articles, the desirability for working to standard types probably becomes greater. We now find some of our railway companies and some of the consulting engineers in Westminster ordering large numbers of engines from America. We believe we are right in saying that they are taking engines exactly to the customary designs of the Baldwin and other American firms which are manufacturing for them, and yet many of these same engineers, if they place an order in England, will not allow the manufacturer to make the slightest deviation from their conventional patterns in the very smallest article. Probably the chief reason why the Midland and Great Northern Railways ordered engines in America was not that they preferred American types, but that they had, through short-sightedness and false economy, allowed themselves to run short of engine power and they were then compelled to do the best they could. I believe that the London & North Western went on building engines steadily all through the times of slack trade, and consequently have had no serious pressure on their resources now that busy times have come upon them. Of course, if Boards of Directors gave as much thought to the interests of the railway as they ought to do, they would also take care to have sufficient reserves of rolling stock and other plant to meet sudden emergencies, whereby they would not only get what they want a great deal cheaper, but they would serve the public a great deal better and make much larger profits.

But besides this, American engines have been ousting English locomotives from South America and many of the Colonies, to a very serious extent; this is probably not entirely on the question of American design versus European, because many of the English locomotive builders have made American-type engines at different times, and would do so again if they got orders; the fact probably is that the American engine is an extremely cheap one to build if made in large numbers. To take one point only; to make a small number of engines with bar frames where the staff and workmen have been always used to plate frames, will be expensive and troublesome until everyone becomes thoroughly accustomed to the change; but anyone who looks at the classes of engine building in an English works will be struck by the unnecessary variation in details—whistles, safety valves, brakes, axle boxes, guides, buffers, and all the endless minutiæ that go to make up a locomotive—which in far too many cases, have to be made absolutely to the instructions, or we may say the caprice, of the purchaser's engineer. This means keeping a very much larger staff of draughtsmen, it means the workmen taking much longer over the work, and probably practically means getting a somewhat inferior engine; because, if a manufacturer repeats an exact article many times, he very soon finds out every possible fault that can arise in connection with it. These can be all rectified and in a short time. whether the article is of the best possible theoretical design or not, it takes a form that can be absolutely relied upon not to break down or fail in practice. I fear that very often the consulting engineer likes to see his own personality on the work he orders and is really, without knowing it, working more to what he believes his own credit than to the benefit of his employers; but, if he could only see it, the official who is most appreciated in the long run is the one who makes everything work smoothly, and who, if he scores no glory for himself, never has any breaks down but always has machinery in the most efficient form.

It is only fair to say that manufacturers themselves are very often very great sinners in this way. For example, if a new workshop is wanted, they put an ordinary draughtsman on to design it in all its details, though it would be probably far better and more cheaply done by some architect who made a specialty of this class of work. The same applies to cranes, and numbers of the other appliances often used in works. We have seen engine builders put up retaining walls and other structures of brick and stone which were simply lamentable exhibitions of ignorance, and such as even an average apprentice who is engaged on a dock or harbour works would see at once to be all wrong. So in the same way, a civil engineer who is preparing to undertake a large public works, the essentials of which he understands thoroughly, will go out of his way to make his assistants design cranes, waggons, and all sorts of things which he could far better have purchased ready made from people who make a specialty of these articles. I have known a resident engineer sent away to a remote country place, with an unlimited stock of drawing paper and stationery, but no designs and nothing to copy; and be there expected, either by himself or with some comparatively inexperienced assistant, to design all the numberless articles of plant that are required to initiate a public works. Now, not only is it a great waste of time and energy to think out on first principles, articles of which numbers of other men have made specialties, but also it is impossible for a man in that position to give to the perfecting of each detail anything like the amount of time that ought to be given. For an engineer to ignore the experience of other engineers in their special lines is as bad as for him to ignore the sciences of chemistry and mathematics, and all the invaluable maxims the knowledge of which constitutes the theory of our profession.

And a very important point is this. Whether in Great George Street, out on public works, or in the manufacturers' office, it is a great mistake to design hurriedly; for to put a draughtsman on to design a great many things, without full time to work them out exhaustively and to make them perfect, is to familiarise him with an inferior class of work, and accustom him to slovenly designing.

When we really talk of designing we ought to be able, first of all, to accumulate all the best information that exists on the matter we have in hand; then we ought to think the question out theoretically and practically, testing every step as we go, and not to be satisfied till we bring out something so perfect that we cannot, by spending more time and thought, make any further improvement. I fear there is no doubt that in this matter the Americans see far more clearly than we do You can find an engineering firm in America that makes only one type of lathe, and only one size of that lathe. Of course, the proprietor knows perfectly well that many other types are necessary, and many other sizes, but his business is to make that one type, and that one size, and make it absolutely perfect; if people want something else, they must go elsewhere. He sees at once that he cannot supply all the wants of the world, and what he wants is to have sufficient business for his own purpose, and in that to supply something better and cheaper than anybody else can give. I believe this way of doing business is eminently successful.

I believe it is much to be regretted that the old system of subcontracting has become to so great an extent a thing of the past. There is no doubt that a man who contracted to supply labour, and employed his own men and boys, had a great deal of power in his hands and this power was occasionally very much abused; we have all heard the stories of cruelty in connection with the coal trade and the Staffordshire iron trade in olden days; but the same power that abolished the sub-contractor could have kept him in order, and were it not for better supervision, better feeling, and the men having better powers of taking care of themselves, abuse would creep in and cruelty and injustice would be just as prevalent under the present system as under any other system. It is a great mistake to abolish a system simply because bad things are sometimes done under it, and the advantages to the working classes of the middle man, or sub-contractor, were very considerable.

First, and by no means least, it enabled a man of ability and energy, without capital, to manage works, to make money by manufacturing, and thereby to save money and ultimately very probably to own his own works. Being also in and among the men, he knew their merits and demerits and had both the power and the interest to appreciate and reward merit in the most effective manner. His hands were not tied, as were those of a foreman, and he could therefore make bargains with individual workmen or praise or blame them just as he saw fit. It may be said that an employer might give his foreman power to do all these things but how few employers can, or will, do so. The employer would constantly have to be in his shop, instead of being in his office or with his customers, to judge as to the foreman's discretion; whereas the sub-contractor, who pays out of his own pocket, has himself to please and pays the penalty of every mistake he makes. Besides, he would very likely devise means of making very large economies, and would thereby make such an income as people will not pay to a foreman, while at the same time supplying the manufacturer with finished goods at the same price, or perhaps a lower price, than they had been made at before, and relieving the manufacturer also of a great amount of labour and anxiety.

Those of us who have been many years in the trade can remember arranging with an individual foreman, or workman, to do so much piece-work and employ his own men. We remember how quickly he spotted the most paying men to take them into his employment; how keen they were to go, and how very willing he almost always was to raise their wages. This system still remains in use in such a case as that of the plater in a ship-yard, who employs a gang of labourers to whom he pays perhaps half again as much as they would earn in the ordinary labour market; and yet, though only an ordinary workman, will take home his 15 shillings to 20 shillings a day for himself; the fact being that if he and his gang put up five plates nobody could say that he had been exactly idle, and yet he puts up a sixth plate in the day, the profit of which goes entirely into his own pocket.

I should here like to make a short extract from "Chordal's Letters," an American book that is not so much read as it ought to be. There is therein a good description of a Yankee contractor—of how he comes into a workshop, sees the standard engine that the firm makes, and, without criticising its intrinsic merits, offers to make these engines at a very much lower price than they have ever been made at before. They have always cost the firm $510, and he contracts to make them at $400. The description takes up his processes, his re-arrangement of the details of the work, and his manner of approaching the men. He finds that one man has been paid $4 apiece for making the crossheads. Under the new arrangements, he is told he must make them for $1. The workman says that at $4 he could only make $1.25 a day for himself; so the contractor agrees to guarantee him something in excess of the $1.25; when the man gets to work, he finds he can easily make $2 a day, and the contractor lets him do so. The end of it is that the workmen make very much larger incomes than they made under the old system; the firm get their finished engines 20 per cent. cheaper, and the Yankee contractor makes extremely good money for himself.

I reserve for succeeding numbers consideration of the economies of standardisation and of labour's interests in the question.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

I.—THE EVOLUTION OF THE TOOL-MAKER.

By permission of Walker & Boutall.

SIR MARK ISAMBARD BRUNEL.

Portrait by Drummond in the National Gallery, London.

TIME was when the general machine shop, with a mechanic of general knowledge at the head of its construction department and, for his subordinates, a force of thorough, all-around machinists, every one of whom was familiar with all ordinary machine-shop operations, was the only machine shop possible. In the year 1800 there were but few machines to be built; there were no ready means of communication, and the machine shop of that day, with its wealth of blacksmiths and hand fitters and wood workers, and its complete lack of anything even remotely approaching the machine tools of the present day, was forced to draw its trade from a limited area. Hence it was compelled to be general in the widest sense of the word and to refuse no order, no matter how divergent from anything ever before produced by the shop. Under these conditions, the best and most successful machine shops were those which had workmen of the most varied experience, and who could most readily adapt themselves to new lines of effort. These early machinists were of necessity men of skill; they were often fine hand workers, and every one of them was to some extent a tool-maker, capable of finding new ways to do the new things constantly placed before him, and of producing tools by which those new ways could be carried into execution. During the fifty years following the year 1800, the steamboat and the locomotive had so drawn the corners of the earth together that a world-wide market became a dimly visible prospect, to the maker of any one machine especially, but it is only within the last ten years of this century that it has become a common and everyday matter for a machine shop devoted to a single narrow line of production to find a market the world over. Hence, as ten years is a very short time for the acceptance of a new fact by the average human mind, there are yet only a few machine-shop managers who fully comprehend the results which are certain to follow narrow lines of specialization in machine-shop product. The short, but successful, existence of the special machine shop points clearly to the following conclusions:

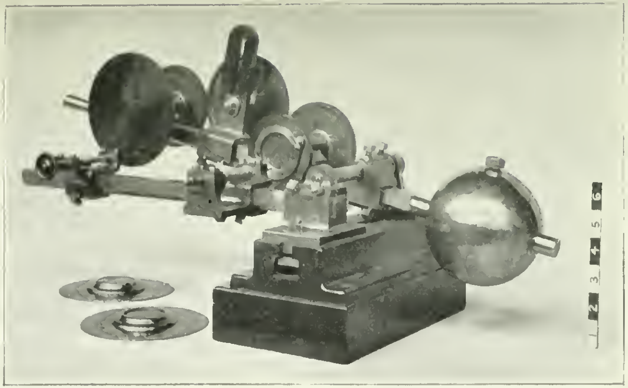
Machinists cannot longer be used to produce the commercial product of machine shops. The production of special types of machines of general application, such as locomotive engines, marine engines and gas engines, slightly varied from standard types, cannot be continued. The consulting engineer, whose principal function is the designing of machines slightly different from standard forms of any particular class, is no longer even a possibly economical factor of machine construction.

Commercial machines, that is to say, machines which are built to be sold and which constitute the saleable output of the machine shop, must be built by workmen who are not general machinists, but who, at the utmost, cannot rank above the skilled laborer, and at the least, may not rate above the wholly unskilled laborer.

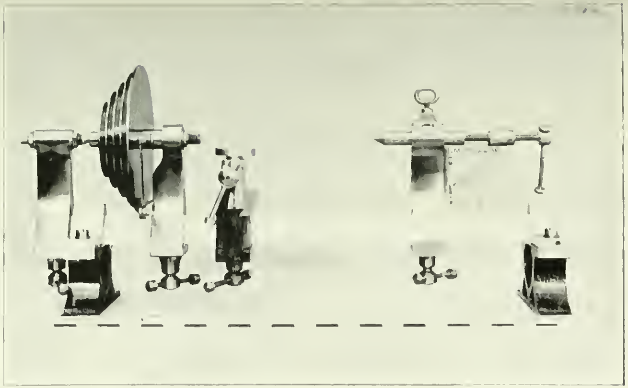
High-grade tool-makers, who are general machinists of the utmost degree of skill and reasoning powers obtainable, must now and henceforth devise the methods and construct the machines, to be used by the little-skilled machine-shop workman in the production of the commercial output of the machine shop.

Individuality of design must disappear from all machines in general demand. Not only must the minor inventor not appear in machine construction as the author of "specifications," slightly modifying standard machine forms, but the really original inventor must remain in seclusion, and unknown as the originator of a valuable advance in the arts, until thoroughly well-made commercial examples of the new thought can be offered to the purchasing public.

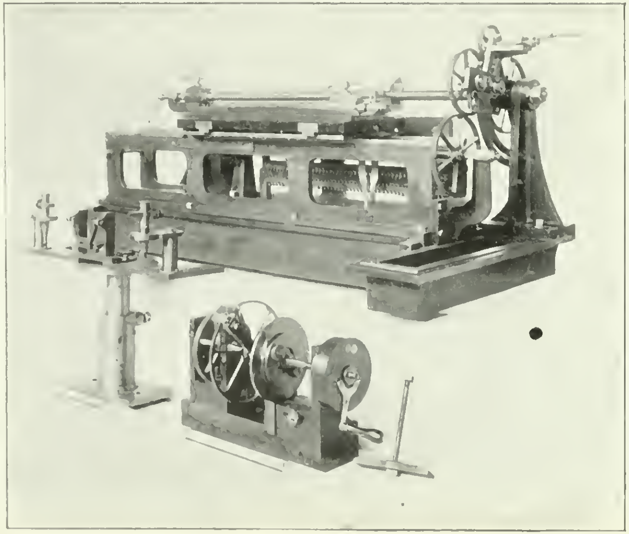
The reason why practice which always has been and to-day is common in the machine-shop, and by many machine-shop managers is still believed to be the only available one under and by which the machine shop can be operated, cannot continue, is that it is no longer commercially profitable to buy and use special types of



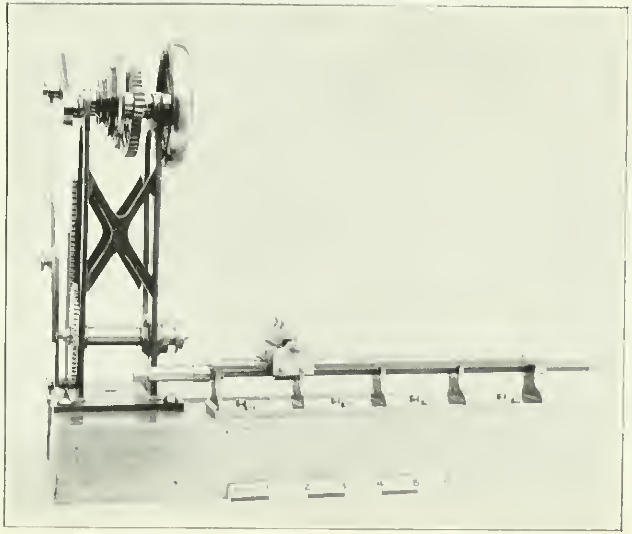
Drilling machine for watch plates. Patented by Roberts in 1848. Drills a large number of holes to standard template.



Bar lathe, made and used by Bryan Donkin, F. R. S. The bed is a triangular bar—the usual form for small lathes at that time.



Donkin's dividing engine, made by Bryan Donkin in 1826. It was also used for originating a remarkably accurate screw thread.



Segment turning lathe. Dates from about 1830. It is intended for turning portions of a cylindrical surface, such as crank cheeks.

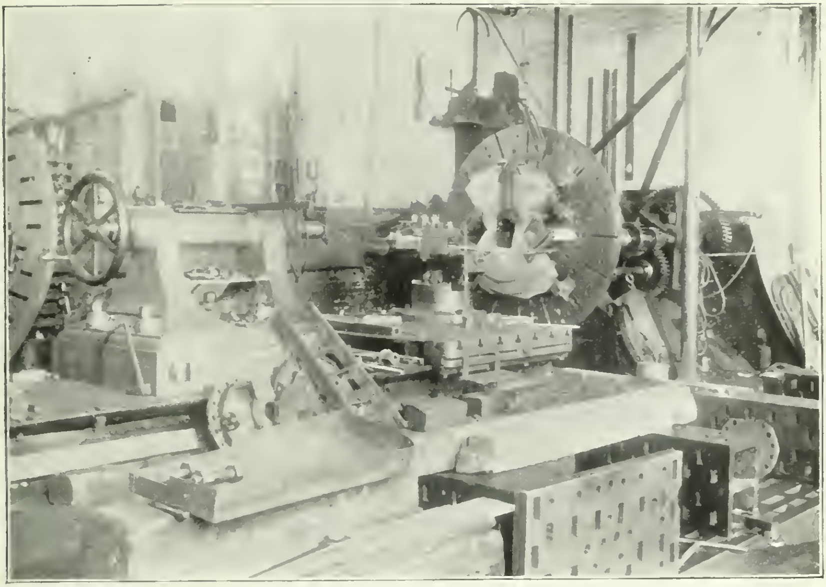
machines which are of general application; that is to say, machines which answer the requirements of entire fields of commercial effort.

This last paragraph can only be true when the whole art of machine construction has so far advanced that really good machines for every commercial purpose are in regular production by machine shops having ample capital. More, all of the machines offered by the machine shops, as constructors and sellers, must be so superior in design and execution that no consulting engineer or other mere adventurer in any given art can, at short notice and small expense, produce a design having points of real advantage over the standard commercial forms.

GENERAL VIEW OF PORTSMOUTH ERECTING SHOP, SHOWING OLD MACHINE TOOLS.

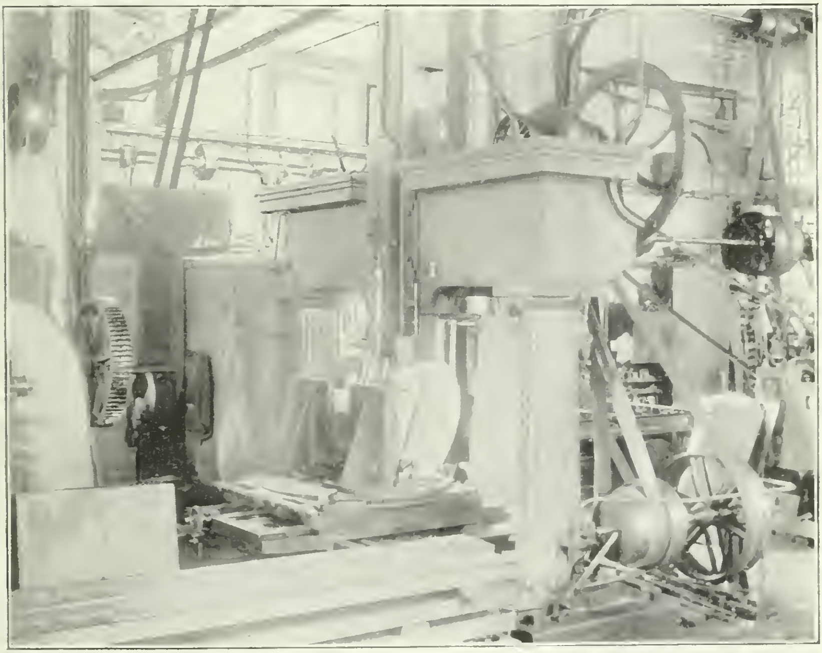
Examples: in small structures, the sewing machine, and the bicycle; in large structures the locomotive and the stationary steam engine. No material modifications of advantage can be made in the forms of these machines for ordinary and general commercial use. These papers do not consider the narrow and commercially unimportant fields of special use, in which minor invention will always be employed by wealth seeking occupation and variety.

Individual impress cannot continue in any form of machine shop production. The operating force of the machine-constructing establishment, which is here spoken of as "The Machine Shop," must consist first of tool-makers, having such natural abilities and intuitions as



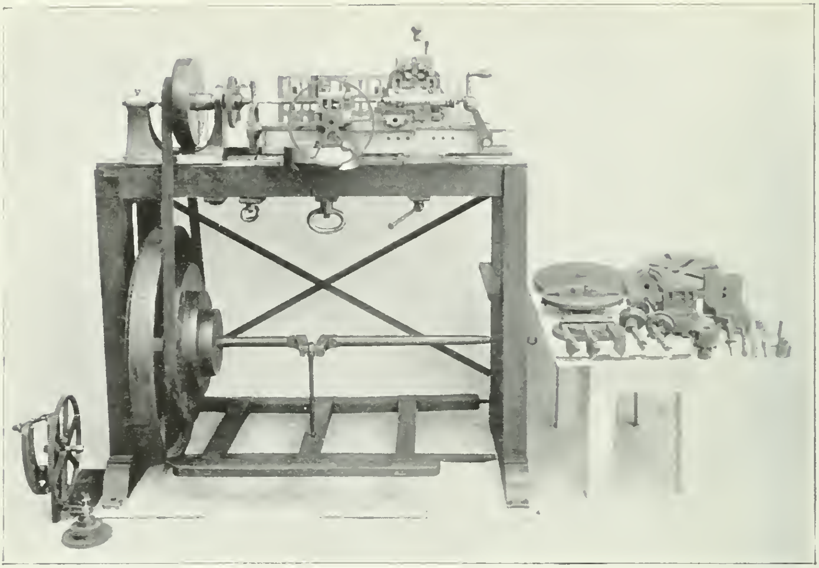
LATHE IN PORTSMOUTH DOCKYARD—NOT IN USE.

3 ft. 6 in. centers and 24 in between centers. Made by J. & D. Glasgow, 1850.



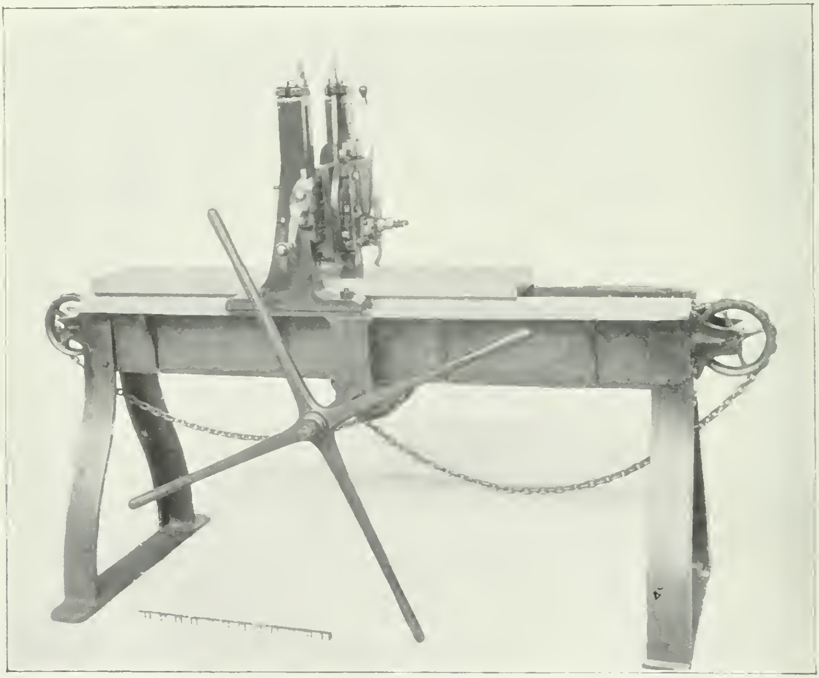
SLOTTING MACHINE IN CONSTANT USE IN GENERAL WORK, PORTSMOUTH ERECTING SHOPS.

3 ft stroke, 12 to 20 strokes per minute; traverse of table. 4 ft. x 3 ft. 6 in. Made by J. & D. Glasgow, 1850.



TURNING LATHE, FORMERLY BELONGING TO CHAS. BABBAGE, F. R. S.

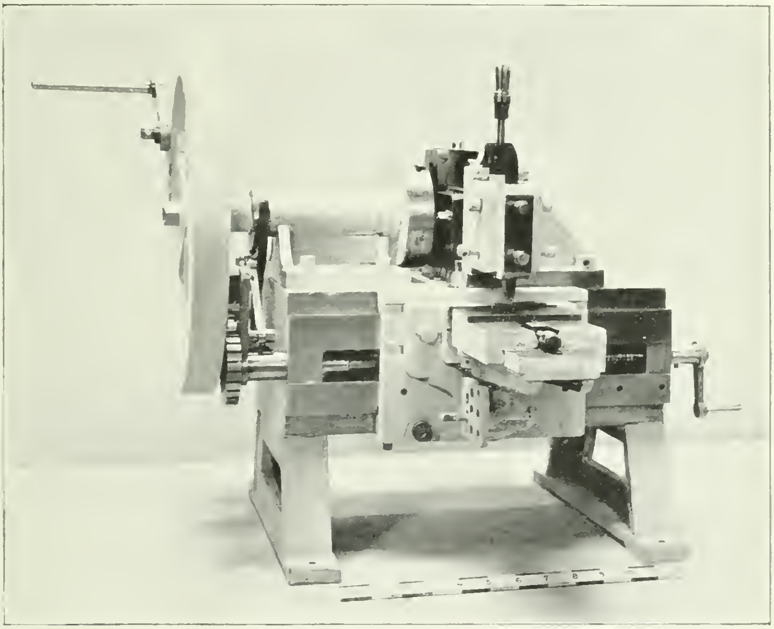
Now in South Kensington Museum. The slide rest is fitted with a face plate and clamps for holding work for milling or other similar operations. It is capable of motion in a vertical plane.



AN EARLY PLANING MACHINE, NOW IN THE VICTORIA AND ALBERT MUSEUM, LONDON.

This machine, made by Roberts, is said to be one of the earliest tools of its kind. Marks on the bed make it evident that it was itself made without the aid of a planer. The table is moved by hand, by chains winding on a drum; the headstock and tool traverse on a horizontal slide.

to enable them to produce, as a matter of routine effort, original and highly effective methods of machine production, together with the tools needed to carry out these methods; and, second, of workers who are in no sense mechanics, but who simply attend the machines produced by the tool-makers, and obediently follow the methods of machine construction laid down by the tool-makers. And there is no limit to the size of the machine upon which labor-costs can be reduced by the tool-maker.



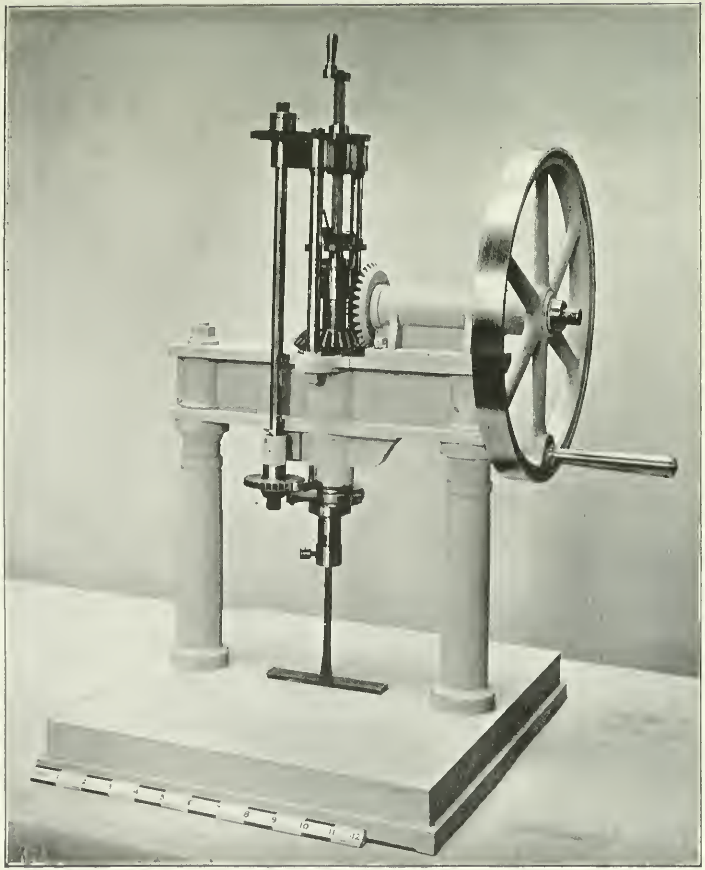
SLOTTING MACHINE, FORMERLY THE PROPERTY OF JAMES NASMYTH.

Now in South Kensington Museum. The crank disc on same shaft with the hand wheel has an adjustable pin in a T-slot, sliding on a block in a slot on the shaping head, which slides in Vs. The work is held by a vise traversed in V-guides by a screw, which obtains its motion either by hand or automatically by ratchet gear and links from an eccentric on driving shaft. The tool base has a vertical screw feed and is hinged.

The only machine shops which can continue to use thoroughly skilled machinists on any part of their commercial production are those which do not make two or more of the same machine at the same time, and the machine-tool shops, which often narrow their field of effort to very few different types, or even one single machine only, and hence have a commercial output consisting wholly of repetitions. In these two cases, extremes meet, and the strictly "general" machine shop, every day growing more rare, and the strongly specialized machine-tool shop, which is constantly advancing in numbers and effectiveness, must both of them continue to use skilled mechanics on their commercial product. The general machine shop cannot place its production under the cheapening reign of the tool-maker, because an order for one machine of a kind at one time affords no economical basis for special methods and tools looking to decrease in labor-cost. The singly constructed machine must be made on general tools, by general workmen, at high labor-cost.

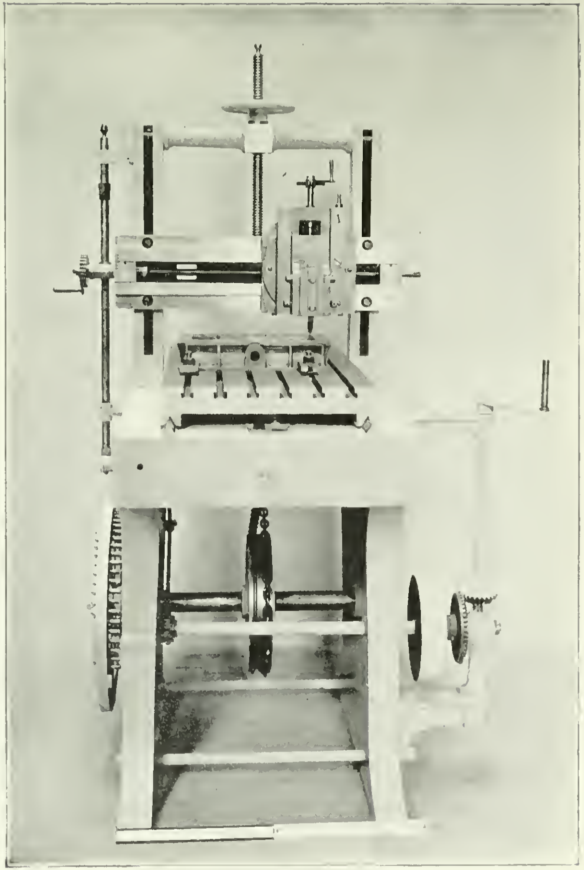
The machine-tool, on the contrary, must be of uniformly high grade and the special machine-tool shop has been so far, and probably always will be, of its own motion constantly lowering the selling price of its product. The excellence indispensable to the machine tool of permanent reputation demands a higher degree of intelligence and skill on the part of the workmen who produce it than can be had without natural aptitude and long training; hence every machine-tool shop must employ skilled machinists on a part, at least, of its commercial product. This fact does not, however, make the machine-tool shop an exception to the assertion that all successful machine shops must have the manual labor sharply divided into tool-makers and machine tenders. In point of fact, a machine-tool shop is not an independent individual machine-constructing establishment standing by itself. Industrially considered, the machine-tool shop must be held to be a part of the tool-room force of each of the machine shops which purchase from it. Thus, to cite the most common of instances, the machine shop which buys a lathe, a milling machine, or a universal grinding machine simply makes the builders of these tools a part of its own tool-making department.

It is worth while to dwell on this matter of close specialization for a moment. Suppose the whole world buys a thousand of some particular machine tool in a year. The customer feeling the need of this tool naturally applies for it to the most conveniently reached machine-tool maker whom he deems capable of producing a satisfactory article; under these conditions, each one of the thousand of these particular tools required might be built in a different shop, and in this case each separate construction would of necessity be treated as a passing matter, to which no great consideration could possibly be given, because the price paid would not permit more care, more thought, and more expense. The result of these conditions cannot be otherwise than inferior, because there is no possibility of recompense for the thought and labor needful to produce the best form of this particular tool. But if all of these thousand tools demanded yearly could



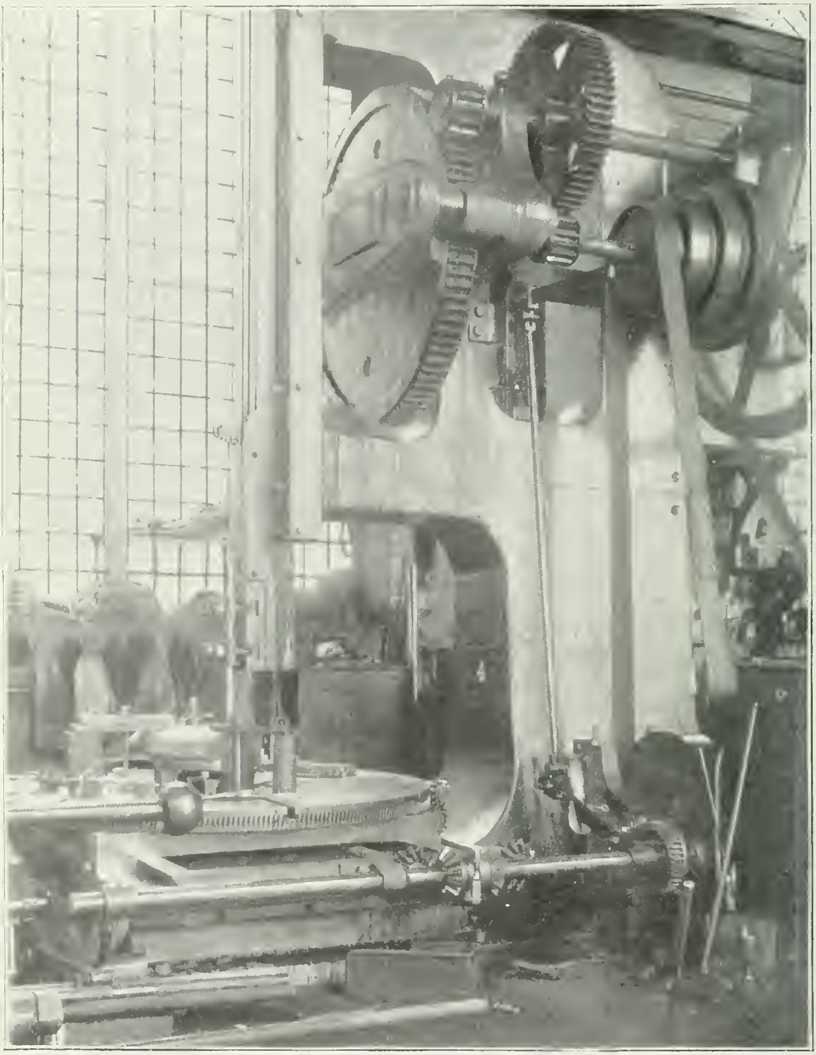
DRILLING MACHINE, FORMERLY THE PROPERTY OF JAMES NASMYTH.

In South Kensington Museum. Resembles the larger types made by Messrs. Nasmyth & Gaskell about 1840. The framing consists of two pillars carrying a cast-iron girder which supports the bevel gear for working the drill spindle. On this latter is an eccentric, which, by a link and ratchet, works a ratchet wheel on a second parallel spindle; this is connected, by equal spur pinions, with a screwed nut on the drill spindle, so giving the feed.



PLANING MACHINE, FORMERLY THE PROPERTY OF JAMES NASMYTH.

Built in 1857; represents the larger type made by J. Nasmyth & Co. about 1840. The small pinion on the driving shaft may be shifted from one side to the other of the pins with which it gears on the large pulley, thus giving the necessary reversal of motion. Chains from a drum on the driving shaft transmit the motion to a table with T-headed slots travelling on inverted Vs.

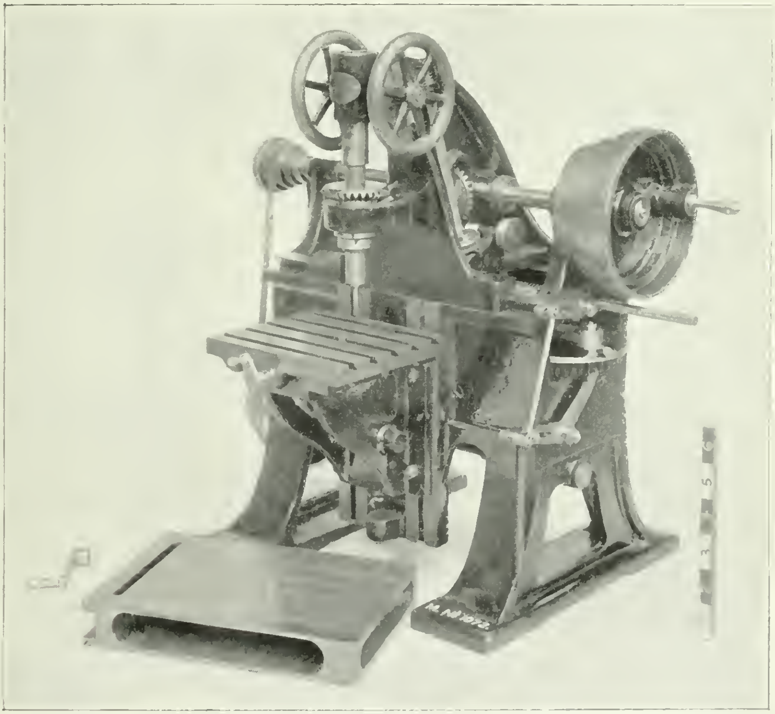


SLOTTING MACHINE IN THE ERECTING SHOP, PORTSMOUTH.

Used for heavy work. Stroke, 3 ft. 6 in.; traverse, 5 ft. 6 in. x 3 ft ; diameter of circular table, 7 ft ; makes 4 to 8 strokes per minute. Made by Collier & Co., Manchester, 1873.

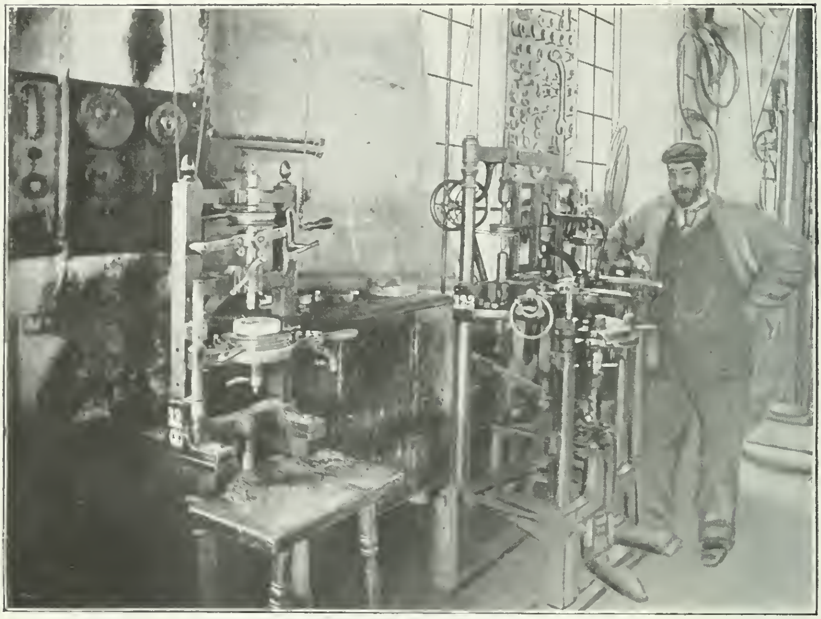
be built in one single machine-tool shop, it is plainly to be seen that the whole force of that shop might well be applied to perfecting the product in every detail, and to cheapening while enhancing its value.

The whole case is Thoreau's legend of the Pilgrim of Koorou over again. This conceit of Thoreau's finds its application in machine-tool construction. A valuable new idea once embodied in metal becomes immortal, and the tool-maker who, from some natural predilection or fortunate thought, is led to devote himself wholly to one production is absolutely certain of a market of greater or less extent, at least until a greatly superior device for accomplishing the same purpose is placed on the market. The chances of the production of a machine tool radically superior, say, to the present best forms of the index milling machine, are so very small as to be wholly inconsiderable. In the year 1800 there were no machine shops, no machine tools, and no machine-tool makers; at that time, any new form of tool which could be proposed was likely to be better than the primitive and inefficient forms in use. Now, in 1899, all of the possibilities have been attempted, and it seems quite safe to say that there are no radically new methods of

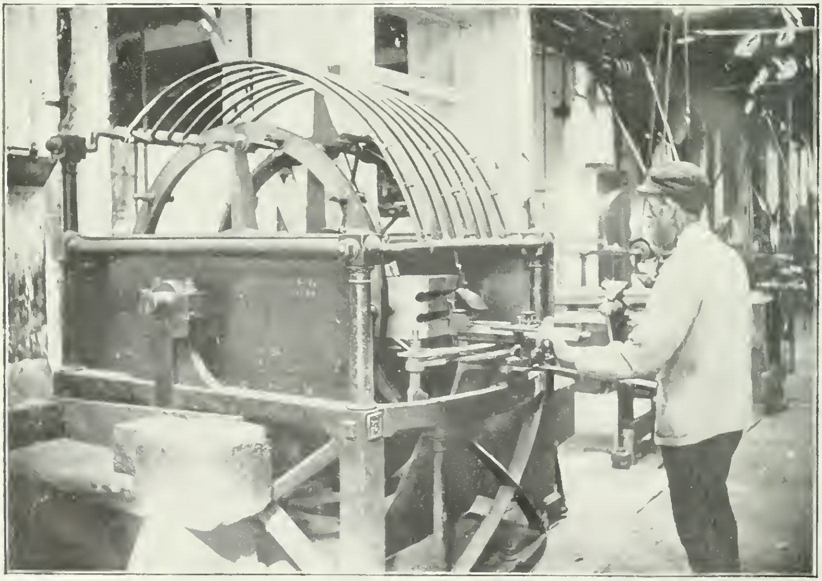


SLOT-DRILLING MACHINE, NOW IN SOUTH KENSINGTON MUSEUM.

Presented by the Institution of Civil Engineers, 1868. Slotted holes are cut by a revolving cutter, somewhat like a drill, travelling slowly over the required length. The head-stock is made to traverse by an adjustable crank motion and connecting rod; the slow intermittent vertical-feed motion is given by a worm and worm wheel, driven intermittently by a ratchet motion acted on by a cam on the revolving crank shaft.



BRUNEL'S BLOCK-MAKING MACHINERY, PORTSMOUTH.
Coaking machines for pulley-sheaves.



BLOCK MACHINERY IN PORTSMOUTH DOCKYARDS.
Rounding and shaping machines for large blocks.

cutting and shaping of metals to be discovered. Hence the key to success is the ceaseless pursuit of perfection with known appliances.

In the case of the thousand machine tools, built in a thousand different shops or built in one single shop, the whole story is made perfectly plain. The shop devoted to a single production, or to a very limited line of production, must infallibly, because of the continued care and thought which can be given to every detail of its production, hold the market against the shop which produces a great number of different machines, even though this shop may have far higher powers at its disposal. No invention is perfected in an instant; on the contrary, endless alterations and experiments are required to bring even the simplest of new mechanical conceptions into the absolutely best form. It is the constant and long continued application of thought which can alone bring perfection, and this is best obtained where few and narrow lines of effort are followed.

BRUNEL'S MACHINERY FOR POLISHING BLOCK PINS.
In the Portsmouth block mills. The machine is now obsolete.

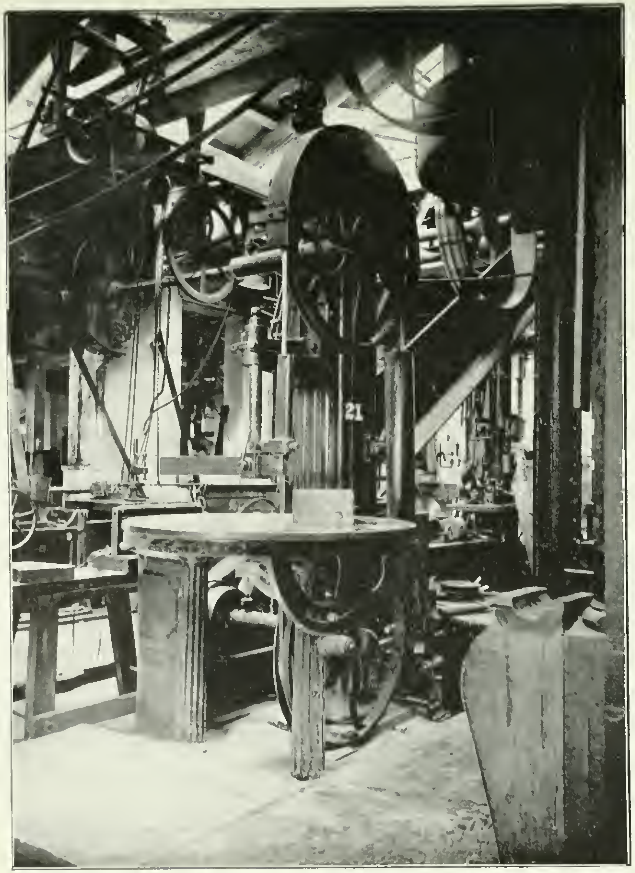
Asserting that the tool-maker is the first essential of machine-shop existence, it becomes pertinent to enquire when and where the tool-maker first became a distinct feature in machine construction, what his actual and possible scope and influence are, and how he is to be distinguished from the skilled machinist.

Speaking narrowly, and within the lines of modern mechanical definition, the first individual to fully comprehend and formulate the possibilities of the tool-maker and his art was Samuel Bentham, who discovered about the year 1791 that intelligence may be transferred from the brain, or whatever, of the machine maker to the machine itself, to such an extent and with such permanence that the machine which the tool-maker has thus imbued with a portion of his own wits can subsequently, so long as it is in working order, supplement with this endowment the small mechanical skill of its tender. Hence the inventor of the method, and the tool-maker who produces a machine by which that method may be cheaply worked, are the most useful benefactors of the human race at large. The inventor of the method first, because he first finds some new thing desirable to be done; the tool-maker next, because he gives a machine such a portion of his own great intelligence as enables the machine to work the new method, useful to humanity at large, without much skill or intelligence on the part of the machine's attendant.

At this moment every step of the world's advance finds its foothold in the machine shop. All betterments of human existence begin in the conception of the new good, but must be made available for the use of mankind at large by the work of the tool-maker. If the toolmaker is competent to impart great intelligence to the new tool he produces, then the labor-cost of the new good at once becomes so small as to make many purchasers possible, and hence, through the great skill of the tool-maker, great benefits go to the human race. Because of all this, deep interest attaches to Sir Samuel Bentham as the first tool-maker to formulate distinctly the theorem that intelligence on the part of the machine maker might make both skill and intelligence needless on the part of the machine tender.

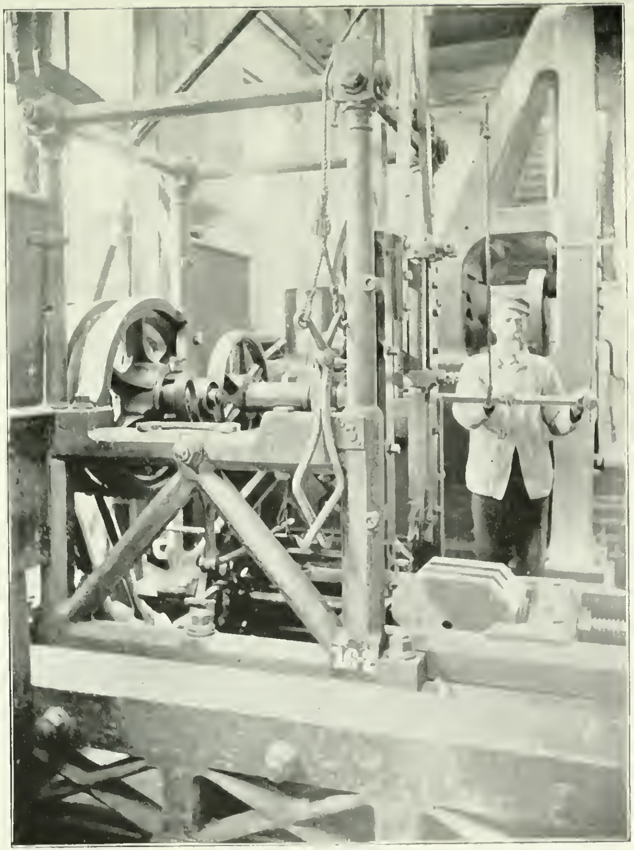
Previous to the time of Bentham there were tool-makers, because every mechanic is a tool-user, and tools must be made before they can be used; and it seems certain there must have been many individuals prior to Bentham to whom Bentham's theorem was familiar. But it was Bentham's fortune to be the first man placed in a position to make the large expenditures of money which alone could fully demonstrate the truth of this conclusion.

Space permits no more than the briefest mention of the early toolmakers and their achievements. The English tool makers were the first to enter the field of actual production of machines for sale by the



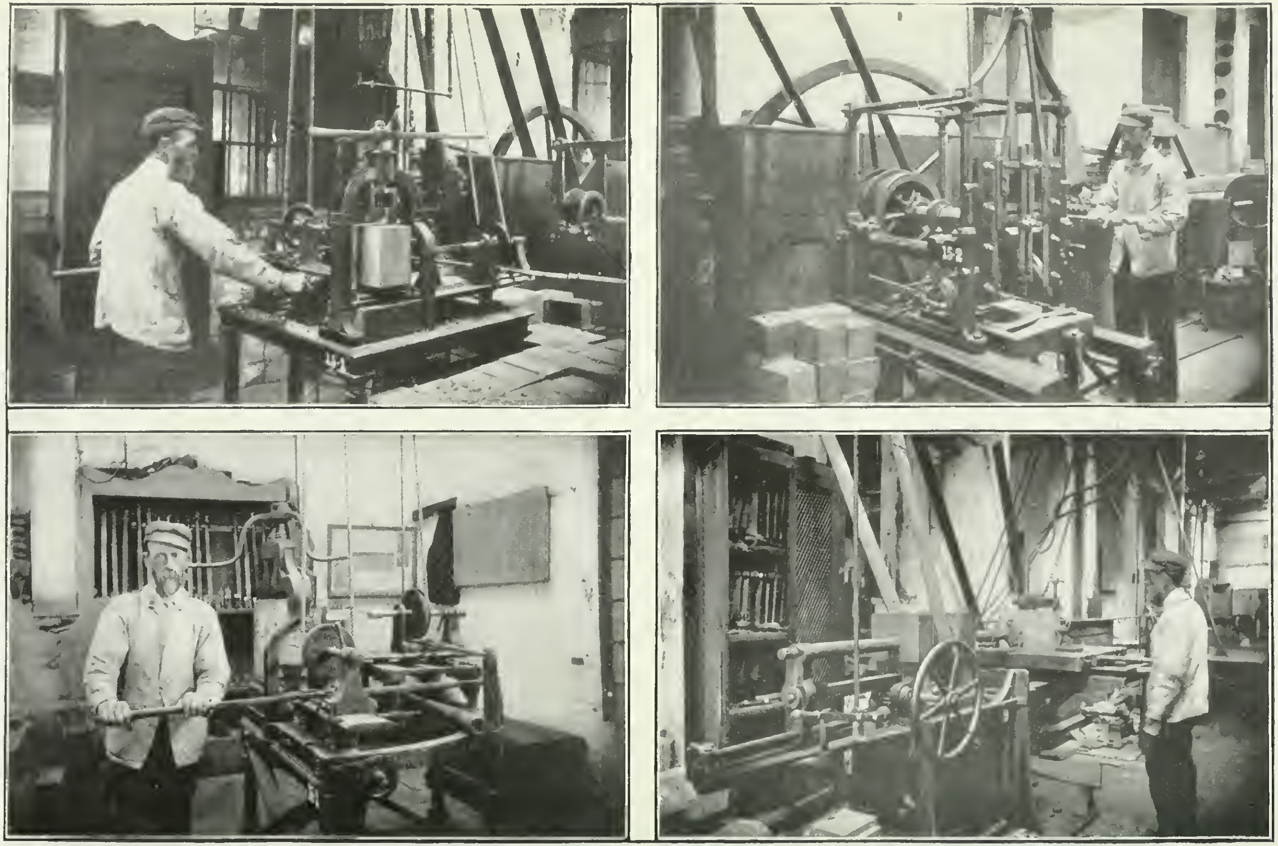
BAND SAW INSTALLED AT PORTSMOUTH ABOUT 1863.

Made about 1840, by Powis, James & Co., for Woolwich dockyards.



MORTISING MACHINE FOR LARGE BLOCKS.

Part of the early block machinery in the Portsmouth yards.



Horizontal boring machine for medium-sized blocks.
Boring machine for large blocks.

Block-mortising machines for medium-sized blocks.
Universal wood-boring machine of about 1820.

BLOCK-MAKING MACHINERY IN THE PORTSMOUTH DOCKYARD BLOCK MILLS.

aid of special tools, and the first to reach commercial prominence was Joseph Bramah, born in 1748. He was a carpenter by trade, afterward working as a cabinet maker in London. Bramah patented his famous lock, long supposed to be unpickable, in 1784 and 1798, and patented his hydraulic press in 1795. He took out patents on improvements in steam engines from 1801. In 1802 he patented planing machines for wood and metals, both rotary and reciprocating, and made milling machines for machining his lock parts, and invented stone- and timber-sawing machines. Henry Maudslay, son of a carpenter, born late in the 1700's, was an apprentice in Woolwich Arsenal, and soon became an expert workman. Bramah heard of Maudslay, and sent for him when Maudslay was only 18 years old, soon making him his head foreman, but, as Bramah would give him only 30s. per week, Maudslay set up a shop of his own, and was the first to make slide rests for metal-working machines of sufficiently good workmanship to show the possibilities of this device. Up to Maudslay's time the best machine-shop equipment known included hand lathes only, boring machines of rude construction, and vertical drilling machines, which it is needless to say bore little resemblance to the vertical drilling machine of to-day. Samuel Bentham, being authorized by the British Government to devise means for employing convict labor, selected the making of ship's blocks as a suitable industry. Bentham patented block machines in 1793.

Marc Isambard Brunel, born in Normandy, 1796, was an engineer by instinct and profession, but never was a practical mechanic. Brunel had considered the block-making problem and had taken out a patent on block-making machinery, and was associated with Bentham. Brunel accidentally heard of Maudslay, and submitted to him drawings of a portion of his block machinery, not disclosing its purpose, but asking Maudslay's opinion as to the mechanical fitness of the forms shown to produce the movements designed. This exhibition of details was thrice repeated, and at the third exhibit Maudslay said: "I see what you are after—you want to make blocks." Brunel then disclosed his intentions fully, and Maudslay produced the block-making plant after his own designs, both Brunel and Bentham being fully convinced of Maudslay's superior fitness. Maudslay began models of block tools in 1800, finished them in 1801, and they were promptly approved. Maudslay's time for the next six years was occupied in equipping a block shop with special tools, which had cast-iron frames, and much hardened-steel work entered into their construction. The first machine-made blocks were produced in 1808. There were many machines in series, and in all no less than 44 distinct new machines of Maudslay's design in the block plant. With these tools, ten laborers were able to produce as many blocks as could be made by one hundred and ten skilled mechanics following hand methods. Maudslay was the first to attempt making screws of uniform pitch and diameter.

Joseph Clement, born 1779, was a natural mechanic, first a thatcher and slater. He neglected his trade to produce a lathe, a microscope and a reflecting telescope at the village smithy, and was afterward a graduate of Bramah's shop. In 1804 he took up the problem of screw making. After leaving Bramah's, Clement became chief draughtsman for Maudslay and Felds, and in 1817 began for himself, with £500 capital saved from his wages, which were at the best 3 guineas per week. Clement began to make taps and dies in 1828. Whitworth was one of Clement's workmen, and afterward adopted Clement's threads in his own practice, which became the English standard. Clement was the first to make a tap with a shank small enough to drop through the hole which was threaded by it. He had a planer at work in 1820, and a more elaborate planing machine in operation in 1824, with stationary tools and moving work, the work-table being carried on rollers.

James Fox, of Derby, England, a cutler, a natural mechanic, was established in the machine business by his master, and made a great success with lace and cotton machinery. He is said to have produced the first planing machine in 1814. This Fox planer had a bevel-gear table action. Matthew Murray, of Leeds, is said to have had a planer at work in 1814. Richard Roberts, born in Wales, 1789, a graduate of Maudslay's, brought out an improved screw lathe in 1816, and his planer in 1817, said to have been operated by "a chain and rack." Roberts was a very able mechanic and invented many machines, including the automatic spinning mule, and in 1834 began the building of locomotives on a large scale; he died in poverty.

This summary of a few of the greatest names must close the record of the early masters in tool-making. Samples of their work are shown in the accompanying engravings, obtained especially for these articles. For the unusual privileges accorded THE ENGINEERING MAGAZINE in this regard, acknowledgements are made to the courtesy of the Admiralty, for the Portsmouth views; to the officials of the Royal Victoria and Albert Museum, for photographs of tools at South Kensington; and to Messrs. Bryan Donkin & Co.

WORKS MANAGEMENT FOR THE MAXIMUM OF PRODUCTION.

By J. Slater Lewis.

I.—ORGANIZATION AS A FACTOR OF OUTPUT.

IN the engineering world, as in many other directions, the present is a time of transition. Under the stimulus of a wave of remarkable prosperity, old-fashioned methods of administration are beginning to show signs of wearing out, and of being no longer equal to the strain and intensity of modern industrial working. Very searching questions are consequently frequently asked as to the probable direction in which reorganization is required.

Prominent amongst these pressing questions is that of "increase of output." With every engineering works in the country strained to its utmost present capacity, this question is in many quarters of Great Britain a vital one, and whilst it is very easy for the merest apprentice to ask it, the answer is not deliverable in anything like simple terms. As the size of the average "works" increases, its problems tend to become complex in still greater ratio, and we find, therefore, that questions of equipment and of organization have begun to assume an importance in the general eye, as factors of production, second only to considerations of design and efficiency in the articles sought to be produced.

This has not always been so. Until quite recently the attention of engineers was almost entirely concentrated upon the latter. The commercial arm of the business and the drawing office have been the happy hunting ground of the principal intent upon progress, whilst the internal routine and administration of shops, save perhaps in matters of purely engineering practice, have been left in the hands of "practical" men, with whom rule of thumb is supreme, and who commonly regard with surprise and contempt any suggestion that their arrangements need constant watching and periodical revision; still more that it is possible to mould them on a well-directed theoretical plan, coupled with a system of record that enables their weak points to be detected and the results of modification instantly to be seen.

Yet when we speak of possible "increase of output," it is not difficult to see that the question is chiefly one of possible modifications in organization. Assuming for the moment that it is not merely technical superiority of one type of machine over another that is under discussion, then we may say that the question is *wholly* one of increased efficiency of organization. If we start from a point where the plant in use has already been modernised—although on that we shall have something to say later on—it is not unfair to assume that to the possible duty or output of that plant there is an ultimate theoretical limit, a maximum of work. But this maximum is not necessarily reached even under the most perfect organization. It might not pay —in many cases does not pay—to reach it.

As between two machines, one of which performs certain work in less time and with less upkeep than another, there can be little necessity for hesitation. The advantage of the machine that cheapens production as well as increases output is too obvious. But between extracting the maximum output from that machine and being content with a less output, very weighty considerations intrude themselves, not technical questions, but questions of organization. These considerations arise from the fact—which is of course known to everyone, but with exceeding rarity realised and given its due value in the economics of manufacture—that the price of doing work at a machine is *not* the wage paid to the man at the machine; there is another factor in the total price of the operation that is always of great, and sometimes of supreme, importance—the price of the organization.

To maintain a shop in full swing costs a considerable sum, and if every machine-man—*i. e.,* every man performing work by aid of a machine—were to give his services absolutely free, there would still be a price to be set upon every piece done, representing the charges o the establishment; this price would be high or low, exactly as the efficiency of organization was bad or good.

It follows from the mutual interdependence of these factors—cost of labour-hours and cost of organization—that with the former constant, *i. e.*, with a fixed time in which output takes place (say the eight hours' day), the total cost of the work will be strongly affected by any variation in the efficiency of organization. If, with the same total cost of organization, we increase the intensity of output, we have a less total price for our work; or if, with the same output over the same time, we decrease our cost of organization, we have again a less total price for our work. It will not be difficult, therefore, to allow the reasonableness of the claim we have to make, *viz., that in a close study of the relative efficiencies of organizations the key to future progress will be found.*

It may be admitted at once that, for such study, no body of data exists anywhere at the present moment. Whilst as regards the bare operation of machine work—the time taken to plane, mill, slot or drill so many cubic inches of metal—data more or less approximate have long been in the possession of engineers, absolutely no record, or at any rate no standard record, exists by which the employer may gauge the comparative efficiency of the arrangements made by his foremen or works managers in all those important items of expenditure which lie outside of, and often bear no sort of relation to, the bare cost of machine work.

For a long time to come this will continue to be the case. Employers capable of taking broad views will no doubt gradually awake to the necessity for accumulating these data; but, until such practice is general, it will too often be regarded as a precious trade secret. Only by the more intense competition of those who have closely studied all the points of production, by means of careful organization and record, will the more old-fashioned employers be forced or frightened into doing likewise, and this information will gradually come to be looked on in the same light as data of technical efficiency, and will become common and similarly valuable property.

It is, of course, obvious that a study of the efficiency of organization is a much more complicated and difficult matter than the mere timing of simple operations. The factors entering into comparisons of machine duty are very few and certain—speeds, shape and angle of cutters, nature of material—all these are easy of reduplication, and variations in any of them can easily be allowed for. The comparative efficiency of various methods of attaining the same end—*e. g.*, planers, millers, turning mills, grinding machines—can also be studied by the technist with ease, and the results set against those of known experience. But when we widen the area of enquiry and wish to know *not* what it costs us to remove a given surface of material in mere labour-hours (*i. e.,* in direct wages), but to arrive at the actual, inclusive, and *real* cost of the whole operation, including the upkeep of the machine in a state of efficiency, the transport of the material from point to point, the share of supervision it obtains whilst under work, the amount of preventible loss and waste due to imperfect process-work necessitating costly hand labour to finish and make complete—*then,* so far as any possible comparison with the experience of others goes, we are at sea indeed. No employer is able to say to himself: "It costs me 5 shilling in wages to plane this slab, and 3 shillings and 6 pence—that is an additional 30 per cent. for cost of organization. This is bad because it is so much per cent. above the standard average." One very frequently hears the question, "What do you pay such and such class of labour in your place?" but never "What is your percentage of shop efficiency?" Yet it should be obvious enough that the latter is the far more important question of the two.

"What," it may be asked, "is the exact meaning of 'efficiency of organization?'" Roughly speaking, it is the ratio of indirect and unproductive expenditure to expenditure on saleable goods or "stock." To place a machine in a shop and a man and a job at it appears very simple; but when we come to consider the case of 100 or 1,000 machines and men and jobs, it may easily turn out that the cost of housing the machines, looking after the men and providing a constant and even succession of jobs, together with the necessary maintenance of the plant in full working order, is the *larger half* of the total expenditure in that shop. But whether it be the larger half or no, its actual ratio to the mere wages of the man standing at the machines will depend entirely on the character of the arrangements made by those responsible for the routine—in other words, upon the "efficiency of organization." With thoroughly modern methods of handling material, keeping up machines to their full capacity, providing an ample supply of cutters and tools, dealing with stores and materials, issuing drawings and instructions to the men, working by jigs and templates and by "stop" machinery, sharp timekeeping and steady control and discipline, it is clear that the indirect expenditure will bear a smaller ratio to direct wages than where frequent stoppages for repair, absence of men grinding up their own tools, reliance on verbal instructions, lax discipline, and ancient and ineffective methods of marshalling, dimensioning, and gauging work are in vogue. In the one case the efficiency of organization is high; in the other, low. This is, of course, generally understood in a qualitative sense; the important point is that this factor of efficiency can be expressed quantitatively, can be represented by figures, and can be worked out graphically, so that the effect of new departures and experiments can be seen whilst they are in the making. And this leads us to consider how the efficiency of any given organization, good or bad, may be studied, and its strength and weakness made manifest.

To attain this end a complete and well-digested system of administrative record should be adopted. Not a mere amateur attempt at adapting an already existing system to local usage, but a carefully-thought-out method, based on the advice of an expert in this particular branch of work. It must not be supposed that to introduce modern ideas in the midst of a conservative establishment is a task to be lightly undertaken. To adopt cut-and-dried methods is easy, it is true; but to educate those who come in contact with and have to work these methods is a more difficult matter, and only those with experience of the work this involves can appreciate the formidable nature of the undertaking. Notwithstanding these difficulties, the matter remains one of vital and imperative necessity. Modernity demands more than that the latest type of machine shall be installed in the workshop; it demands that a very precise knowledge shall be available of the difference the introduction of that machine has made upon the general efficiency of the undertaking. It demands that the organization, amidst which the machine is set, shall be as up to date as itself.

A great many persons entirely miss the point of advantage to be gained by a carefully-elaborated system of record in the internal administration of works. Old ideas die hard, and, since the cost of operations is still the principal element in such records, it is assumed that to produce more accurate "cost accounts" is the whole end of the reforms proposed. "Our costs are quite sufficient for us; we know what our work costs us in labour and materials; we know what to sell at," is the usual reply one gets when urging the utility of more modern methods. Now, apart from the fact that no system of cost accounts which *merely* registers material and labour is any trustworthy guide to the profitableness—or the reverse—of any particular "line" where the margin of profit is very small, or where widely-different classes of work are concurrently passing through the same shops, the object of modern methods of record is quite other than that of a system of cost accounts. That it fulfills the functions of this is quite true; but it has much more extended and even much more important aims.

The real object of modern organization is to strengthen the administrative arm in its control of routine, and to keep it closely informed as to fluctuations in sectional and departmental efficiencies. A modern system of record, at its best, is a kind of registering barometer, and the analogy is so close that fluctuations, in the one case as in the other, may be represented by a rising or falling line upon a chart as already mentioned. But there is this difference—and here the analogy fails and the advantage lies with the system, rather than with the instrument—that the former *tends to shape its own results.*

That this is so will be better understood when we have considered what demands on its managers a modern business makes, bearing in mind that, however wise and shrewd such management may be, it must, in a large undertaking, rest ultimately on two things—(1) the degree and intimacy of knowledge conveyed to the management of what is actually going on in the works; and (2) the perfection of the arrangements by which the matured judgments, based on this knowledge, are realised and carried into the furthest details of routine.

The ultimate objects of a manufacturing business are the production of a given output with the least possible expenditure of direct wages and indirect expense, and its disposal in the market at a minimum of further expenditure. This, however, is a very bald statement. In practice many considerations occur to modify profoundly the race for lower expenditure—but this fundamental principle is never to be lost sight of, and indeed its modification is apparent and temporary rather than real and permanent. These considerations are of two kinds, affecting the manufacturing and commercial sides respectively. In both cases the welfare of the *organization* demands a certain amount of study and absorbs a certain share of nutriment for its upkeep. If we may adapt a physiological parallel, the health of the body generally must be maintained at a high pitch if the best results are to be expected from the applied functions, whether these be wood-cutting or war-strategy. Similarly, between the desire to produce and sell cheaply and the desire to evolve and maintain a high standard of organization, capable of meeting various and sudden demands and developments that may arise from unforeseen circumstances at any time, a true balance must be held, tending neither to stint and starve the organization for the sake of immediate results, nor, on the other hand, needlessly and uselessly to pamper it, so that it absorbs more than its proper share of the common vitality.

Thanks to the absence of data upon which to base comparisons, this point at which organization ceases to be an assistance and becomes a burden, a mere incubus draining the life out of an undertaking, is one which can by no means readily be defined. Every class of business, and almost every individual business, will vary in the ultimate degree to which organization may be usefully involved; but, generally speaking, all arrangements which tend to bring out into light of day or under the direct control of the management the aggregate effects of changes made in the conduct of the business, however trifling each of these may in itself appear, will prove of ultimate benefit; and by "changes" must be understood not necessarily special developments, such as the introduction of new machinery, but also all fluctuations in any of the factors which go to make up the totals of outgoings, and, not less important, of incomings.

That business is notoriously best served whose welfare is constantly under the eye of a capable principal. But to the very possibility of such intimate personal supervision there are quickly found limits, beyond which reliance on subordinate responsibility becomes inevitable. Now, the true functions of a proper system or organization are (1) to prescribe, on carefully-thought-out plans, the directions in which each subordinate unit may most usefully exert his energies; (2) to gather and summarise, in graphic and visible form, the ultimate results of all these distinct channels of energy. Organization necessarily oversteps its mark and becomes superfluous when it fails to do either of these, or to present results in such pliable form that they present, to the mind of the principal, information on exactly such points as would, in a smaller business, be covered by personal attention and knowledge, and on some others of which we will now speak.

If we consider the details that a capable principal has under his immediate observation in a business small enough to be efficiently managed by personal supervision, we shall be able to enumerate some of the more essential points of organization on the larger scale. As buyer of raw material he is keenly alive to the relations between a rising or falling market and the costs and sale values of his products. He knows almost instinctively at what point economies neglected in busy times must be resumed. As payer of wages, he has before him constantly the ratio between his pay roll and his output. As a constant spectator of actual operations in the shops he is early aware of slack discipline, and can distinguish between well- and indifferently-managed departments. He takes personal notice of the extent of employment of his machines, of the effect of overtime or night work upon intensity of production, of the degree of repair in which his plant is kept, and of the consequent full use, or waste, of time incident thereto. Waste, in fact, of all classes is one of the points to which personal attention is most easily drawn. Even where the most elementary kind of costing arrangements are in vogue, the truth or otherwise of their results can be checked with sufficient accuracy. And with a practically fixed and unchangeable incidence of establishment or "indirect" expenditure, this latter most important item is understood by him in all its bearings as a matter of practice, if not of theory.

In all these cases, indeed, practical instinct, sharpened by the vital importance, to him, of the general result, will enable the shrewd principal to give a very good account of his undertaking. It is not even necessary (and in most cases it is not actually the case), that he shall have any theoretical perception of the bearings of these factors one upon another. These elements and relationships existed, of course, before they were studied and supplied with names, and to a given extent no further complexity is necessary or desirable. But just as to lead a dozen men is within the powers of a corporal or sergeant, so, in the one case as in the other, as the numbers increase, does the necessity for a wider intellectual survey. To manœuvre a battalion requires a grasp of a number of points wholly absent and having nothing corresponding in the case of a squad. To the instinct and direct grip of personal supervision succeeds the power of directing an organization, and the two have perhaps not much in common. The head of a large business deals no longer with things but almost wholly with capacities; and it is towards discovering and employing to the full the capacities of those associated with him subordinately that all his arrangements must thenceforth tend.

It is because nearly all large businesses are the (often rapid) outgrowths of originally smaller ones that the question: "What is a suitable degree of organization?" can hardly be answered without reference to the circumstances of the particular case.

It is evident, however, that in addition to knowing all the prime elements of production present in a small undertaking, much more is required. For the first time the relations of these elements are no longer the subject of instinctive perception; they require to be placed artificially in juxtaposition, and in doing this mistakes may easily be made, and the whole trouble and expense of organizing be rendered nugatory, or the results even become dangerous and misleading.

It is not to the present purpose to attempt to indicate the lines on which organization should proceed, but rather to urge the importance of the fullest possible grasp of the principles upon which all good modern organization is based, and particularly to show that a mere "cost system," however essential to both large and small works, does not, and cannot, furnish answers, either in kind or in degree, essential to the highly-efficient administration of large ones.

To know when, where, and how economies may be effected, production stimulated, and the links of a prompt and efficient supply be tightened up is of the first importance. This involves a rigid departmentalising of the undertaking, and a separation at every stage of the "prime," the manufacturing, and the sale-organization costs. Between such independent departments, on the other hand, the most complete accord must exist, and their smooth interworking be made the subject of constant watchfulness and record. Time is of the most imperative importance in manufacturing operations, and a consolidation of the routine should be evolved, so intimate that deliveries can be forecasted like the arrival of trains in a railway time table, really extraordinary circumstances of course excepted.

The *manufacturing* possibilities of a works, as apart from its engineering side, are becoming a subject of close study with all firms who have their eyes upon the tendency of the world's business towards further and yet further specialisation. Mass production and the standardising and unification of parts, with which it is of necessity connected, cannot be conducted save on lines of the most rigidly-exact organization. It is not merely sufficient that the technical portion of such operations be modernised. Automatic and stop-machines will not of themselves produce either a large or an exact output, but must be themselves made part of a system arranged to suit the changed conditions of work in order that their real superiority may become available.

There are some obvious points in which practice may be improved upon. It should be recognised that the internal organization of works lies neither wholly in the province of the engineer nor in that of the accountant. Primarily the object of such organization is for settlement of routine, and secondarily for recording the results of manufacturing operations. But, whilst the accountant looks only to the *final* result, the ultimate cost of every completed order, the engineer requires to follow not so much the final result as the gradual upcreep of detail after detail of expenditure by which that final result has been attained. Therefore, what will fully satisfy the needs of the accountant is of scarcely any value to the engineer. And, as a result of this curious position of affairs, this conflict of interests, the whole question of internal organization is the most undeveloped and backward section of the engineering industries.

In most places the accountant and his needs are considered paramount, and the application of clerical labour in work not directly involving the getting out of costs is looked on as a "fad." But not only is the predominance of this element hurtful to the due development of a proper system of organization, but it is often almost ludicrously the cause of great inaccuracies in the final results so sought after. In many places where the most elaborate bookkeeping prevails the question of *correct* allocation of time is one entirely outside the purview of the bookkeeper, and is left very often to the taste and inclination of the individual workmen concerned. A similar looseness not infrequently prevails as to dealing with stores. Yet it is obvious that the *first* effort of organization should be to collect the elements in a correct form. On the other hand, no greater error can be made than to multiply clerical work in the wrong place. The time of foremen is not to be taken up with such duties, for obvious reasons; generally speaking, whatever arrangements are made within the shops should be made with a full sense that they must, to work satisfactorily, be accepted by those who have to deal with them as helps and not as hindrances. This is difficult, but it is by no means impossible.

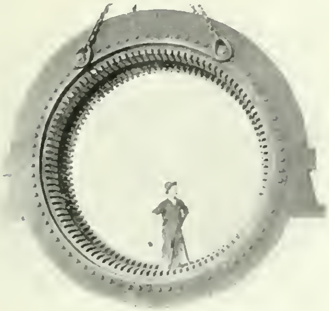
At the risk of tiresome reiteration, the position with which we commenced must again be emphasised. The problems of the future are, in a sense never before reached, problems of organization. In whatever direction we look, whether it be a case of specialised output, of new methods of manufacture, or of simply increasing the efficiency of existing plant and methods, the necessity of studying the points involved by the aid of the most advanced and recent devices becomes evident. It is not enough to accumulate detail; it must be digestible detail. It is not enough to know roughly the cost in labour and materials of every article passing through the shops; it is necessary to establish a connection (and a well-thought-out and accurate connection, or the result will be misleading and disastrous) between every such article and the amount of indirect expense it may have incurred or absorbed on its way.

Loose percentages, or estimated incidences of expenses to costs, will no longer serve their purpose as a guide in the circumstances of intenser production which are being forced upon engineers. Distributions of actual expenditure over actual work, double-locked in every direction by financial balances; the abandonment of the old and clumsy device of machine-rating as a factor in cost-keeping; rigid separation of the cost of selling from the cost of making; a plentiful use of the graphic (chart) methods of representing what is going on, within and without; prompter and more automatic methods of allocating workmen's time to orders; the abandonment everywhere of verbal in favour of written instructions; greater attention to methods of securing the smooth interworking of separate departments—these are some of the directions in which advance is necessary and in which otherwise well-equipped and organized establishments are clinging to the methods of their forefathers, and without reform in which their best energies cannot be properly directed.

Reorganization is not, however, necessarily limited to administrative arrangements. The reward of labour, the reduction of the labour-factor itself, the fuller utilisation of plant, and the marshalling and arrangement of work, are all questions of organization in greater or less degree; but these, together with that of specialisation of output, must be considered in following issues of this Magazine.

ELECTRIC POWER IN ENGINEERING WORKS.

By Louis Bell.



MODERN manufacturing plants are, according to the nature of the product, very variously organized, but the basic principle of their industrial evolution is tolerably distinct. It is, briefly, to regard the whole establishment as a gigantic machine tool, enormously complex sometimes, containing many parts specialized for some particular duty, including some human semi-automatic feeds, belt shifters and conveyers, which are to be treated with the same nice consideration as the rest of the mechanism, but altogether constituting a well-regulated apparatus for turning out finished work. The superintendent directs the operation of the whole and the foremen serve as oilers and wipers.

This is not exactly a humanitarian point of view, but humanitarianism is seldom allowed to obtrude in matters of this kind, and we may as well recognize the condition as it exists.

Now, there are three principles of economy that underlie the efficient operation of any machine tool. First, keep it working steadily at or near its rated capacity; second, keep down friction, backlash and lost motion of every kind; third, keep down the manual labor—it eats into profits. It is not difficult to show that, in the practical application of these rules to the organization of a manufacturing establishment, the use of electric power may be—and is—a very important factor. I do not propose to deal here with any advantage that may come from using power electrically transmitted from a distant water power or coal mine, but merely with its application to the working of the industrial machine.

As regards keeping up the load factor, there are several distinct considerations involved. First, the mechanism as a whole should be kept at steady output every working day of the year; next, each element of the machine should be worked at load when it is worked at all. In brief, the plant should have no periods of inactivity and no parts running idle. Unhappily, electric power can have little effect in the first particular, save as it tends in general to cheapen production, and, as a rule, the plant which can turn out goods most economically will be the last to shut down. But the usual cause of irregular operation is unscrupulous competition in the disposition of the finished product, causing very irregular demands for delivery, which fall with particular severity on industries in which the proportionate cost of material makes it burdensome to carry a heavy stock.

Such competition is almost as great an industrial disaster to the community as no competition at all.

In keeping up the load factor at any given time, however, electric power has again and again demonstrated its value. The subject has been threshed over many times, and each investigation has led to the same result, showing clearly that, by eliminating the waste power which comes from idle or under-loaded shafts and gears and slipping belts, through recourse to electrical driving, a very considerable saving in the net cost of power may be effected. The mooted point at present is not whether it pays to distribute power electrically, but what degree of subdivision of electric power gives the greatest economy. The weight of the evidence points to the use of a separate motor, not for every machine, but for each operative unit, whether this is an individual drill press, for example, or a group of a dozen automatic screw machines. Such a combination of group and individual driving greatly lowers the first cost of the installation, and gives, on the whole, better economy than the extreme plan of a motor for each machine.

Fig. 1, a group drive of spinning frames in an electrically-operated cotton mill, is a good illustration of a case in point. Here the ultimate mechanical unit is the spindle, and it is conceivable that a separate electric motor might be applied to each individual spindle. This would involve an enormous multiplicity of very small and inefficient motors. The next stage would be to apply a motor to each spinning frame—to which, in less degree, the same objection would apply. The method taken in this case, however, is to regard as the operative unit such a number of frames as, taken as a whole, will be in steady, continuous operation, and to assign a single motor to each group. In point of fact, the whole spinning room is an operative unit; but, as the number of frames driven from a single motor is increased, a point is finally reached where a further increase will result in more loss in shafting and belts than would be incurred by subdividing the motor units.

This sort of problem is the one which has to be solved in every application of motors to manufacturing purposes, but in this case it appears in unusually definite form. In machine-shop practice the operative units are less easy to determine. It is worth noticing, too, that in cotton-mill driving the electric distribution of power has the advantage of keeping the speed keyed up to the best working conditions all the time, by eliminating nearly all the creeping of the belts, so that, as a matter of experience, it has been found possible to operate an electrically-driven mill at a slightly greater average speed than if power were distributed by shafts and belts, and hence to obtain a very perceptible increase of output.

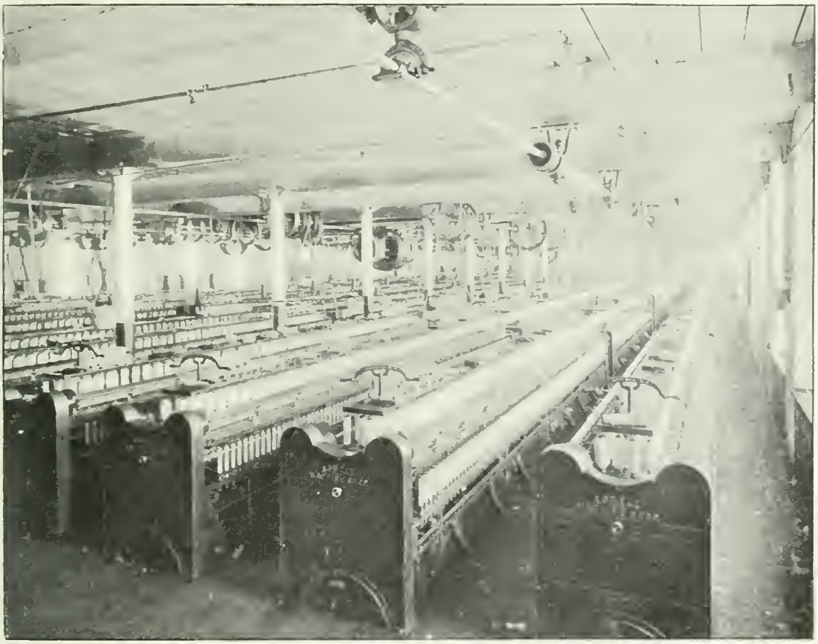


FIG. 1. GROUP ELECTRIC DRIVE OF SPINNING FRAMES IN A COTTON MILL.

An instance of advantageous grouping of many small units for operation by a single electric motor.

Apart from this, the ability to run a few departments without working most of the shafting for the others is in itself often valuable. A case which recently came under my observation was that of a manufacturing establishment in which departments were successively shut down during a week of stock-taking. Starting with nearly full load, the useful work by the end of the week was trivial; but most of the shafting had to be kept in operation all the time. It is almost impossible to strike an average of the shafting distribution losses in large works. They may, and actually do, vary from fifteen or twenty per cent. to seventy or eighty. It is probably within the mark to say that, in most large establishments, the cost of power—and by this I mean the net cost—can be reduced twenty-five per cent. by the skillful application of electric driving. Each case, however, has to be considered by itself; the above figure is derived from personal investigation of a number of cases in which electrical operation was contemplated.

Far more interesting are those applications of electricity which have to do with avoiding lost motion—to speak generally. The immense amount of this which exists in many large works can be fully appreciated only by one who has been intimately connected with them. The machine-tool conception of the factory is beautifully efficient in principle, but it has one weak point which often escapes notice—and equally often leads to grievous results. And this flaw is the suppression of the feeling of personal responsibility in the human part of the mechanism. Carried to its logical conclusion, the prevalent idea of organization leaves, as mentally active agents, the superintendent, the head draughtsman, the tool makers or pattern makers, and the inspectors. If these last do their whole duty they may keep the product up to the mark, but they usually degenerate into a species of walking templet, and the product suffers. If each component part of an article is made by a workman whose only interest is in forcing out of his machine as many pieces as possible, good enough to pass an inspector whose work has become a feat of unconscious cerebration—the assembled whole is likely to be only passable, and the blame cannot be fixed on any definite victim. The best of which the system is capable is the production of a pretty good average. The same fault appears in every case in which the subdivision of labor is carried far enough to stifle the sense of individual responsibility. When the workman ceases to be a mechanic and becomes merely an operator on a No. 4 B, Schmidt Automatic Planer, adequate inspection begins to be costly, if anything but coarse work is in hand.

Furthermore, in large and highly specialized works it generally costs much valuable time to transmit an idea from the superintendent through the red-tape office to the proper departments. It actually is a fact that, in not a few thoroughly organized concerns, particular items of the product cost more to produce than when made in a small shop elsewhere. The point is that there is too much lost motion and too little responsibility involved in specializing all the mechanical

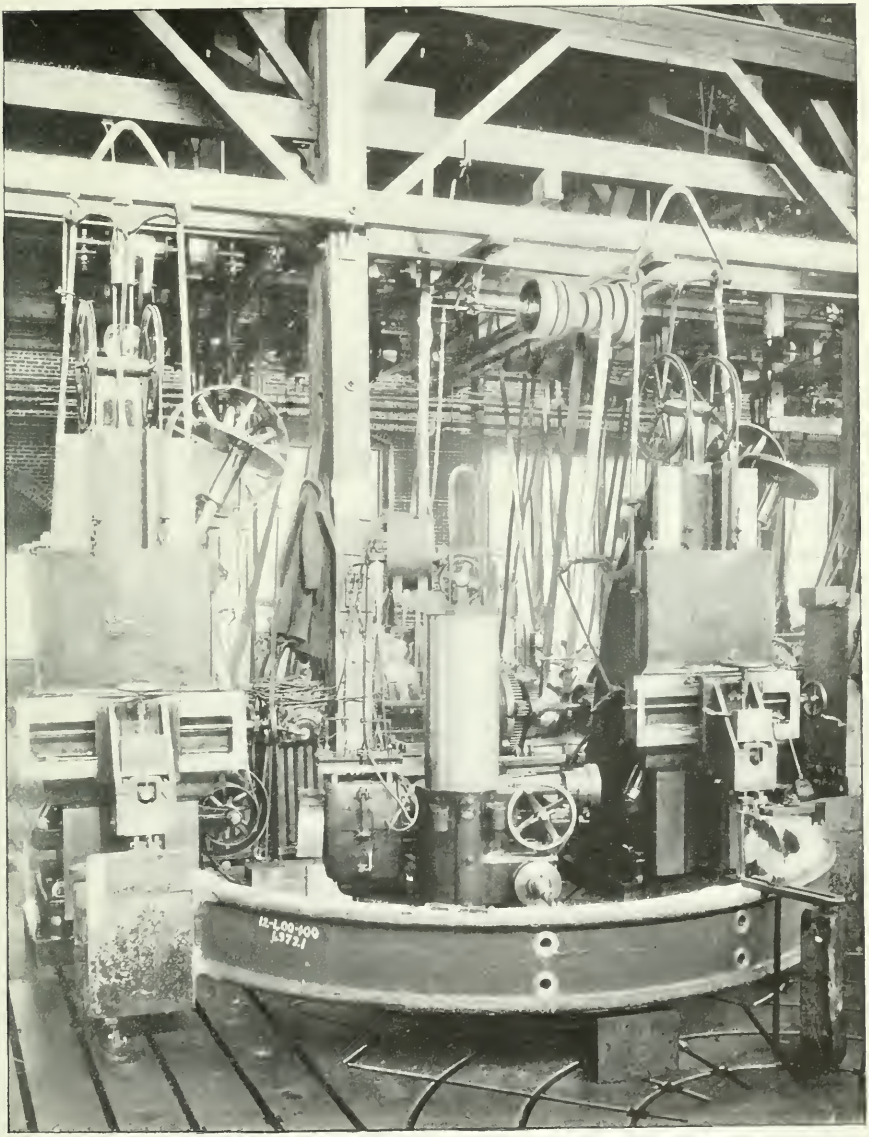


FIG. 2. PORTABLE DRILLS AND SLOTTING MACHINES AT WORK ON A DYNAMO FRAME.

An example of the gain in convenience and saving of labor through bringing movable tools to stationary heavy work.

operations, and better results could be obtained by putting the manufacture of that particular thing in a corner of the works by itself and holding the foreman responsible for the product.

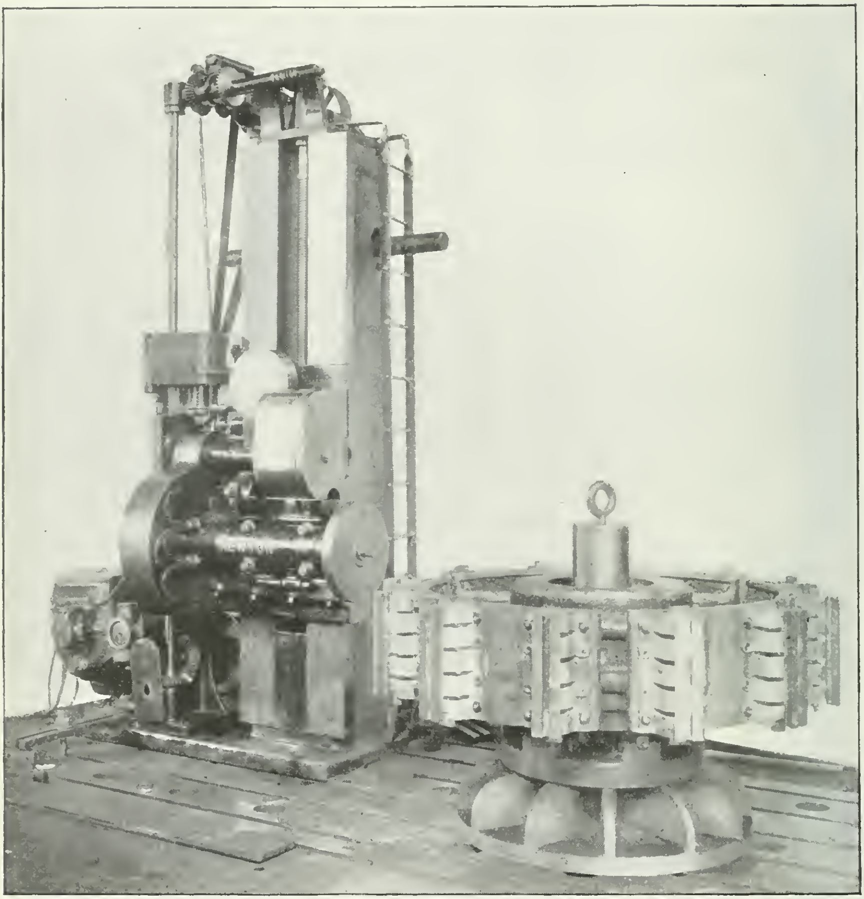


FIG. 3. PORTABLE MILLING MACHINE, DRIVEN BY A 12-H. P. MOTOR.

Another instance of the great convenience of moving the tool rather than the piece to be operated upon.

This digression on uneconomical specialization is a rather long text for a rather short sermon, but the truths set forth have been many times forced on my attention, and it often happens that shrewd applications of electrical driving can take up much of the lost motion and make it possible to secure cheaper work than could be done if the ordinary routine of subdivision were followed. In other words, one can take a short cut instead of going the long way around.

As an example, take the tool work done on heavy castings. Ordinarily, this taxes the resources of the biggest machines in the shop, and I have often seen a big gang of men wasting an outrageous amount of valuable time in getting the work into position. In a properly equipped modern shop, the fact is recognized that it is easier to bring Mahomet to the mountain than the mountain to Mahomet, and portable machines are brought into play. Fig. 2 gives a good idea of their use. The casting is swung by an electric crane upon the nearest available space of iron floor, gridded like the bed of a planer, the tool is dropped into position by the same means, both are made fast, the motor is started—and the work begins. The machine shown in the center of the cut is a large portable drilling machine driven by a 3-h. p. motor, while on either side, made ready for work on the same casting, is a powerful portable slotting machine to which is attached a 12-h. p. motor. All three can be set at work together on the huge dynamo frame, once it is bolted into position, and can quickly be transferred to another field of labor when this particular job is completed. The result is not only an immense saving of time, but an escape from the necessity of putting an unwieldly mass through the regular sequence of machines ordinarily employed on smaller work. Where big work is to be done, there go the portable tools, leaving for the specialized routine the work which can profitably be assigned to it. Fig. 3 shows an extremely useful portable milling machine driven by another 12-h. p. motor, ready for work on a massive spider.

The great ease with which electric power can be distributed to portable tools makes it invaluable when very heavy work is to be done, and in big engineering works, ship-building yards and the like, it has so great advantages as to make its use highly desirable, quite aside from the absolute saving in cost of power. Even on lighter work similar tools can often be profitably used, and Fig. 4 shows a very convenient combined drilling and milling machine worked by a 3-h. p. motor and admirably suited to save time and labor.

In the construction of modern steel buildings there is an excellent field for the lighter portable machines, for current can nearly always be obtained from the street mains. In one instance, where portable machines could not be readily obtained, some deep steel beams were cut clean off by burning across with a powerful electric arc, and thus fitted to their places at a prodigious saving of time and money. For quick emergency work in contracted spaces and where proper tools are not at hand this arc process of perforating and cutting comparatively thin material is not to be despised; it is extremely simple and by no means so inefficient as it might appear.

In extensive works where the subdivision of labor is quite complete

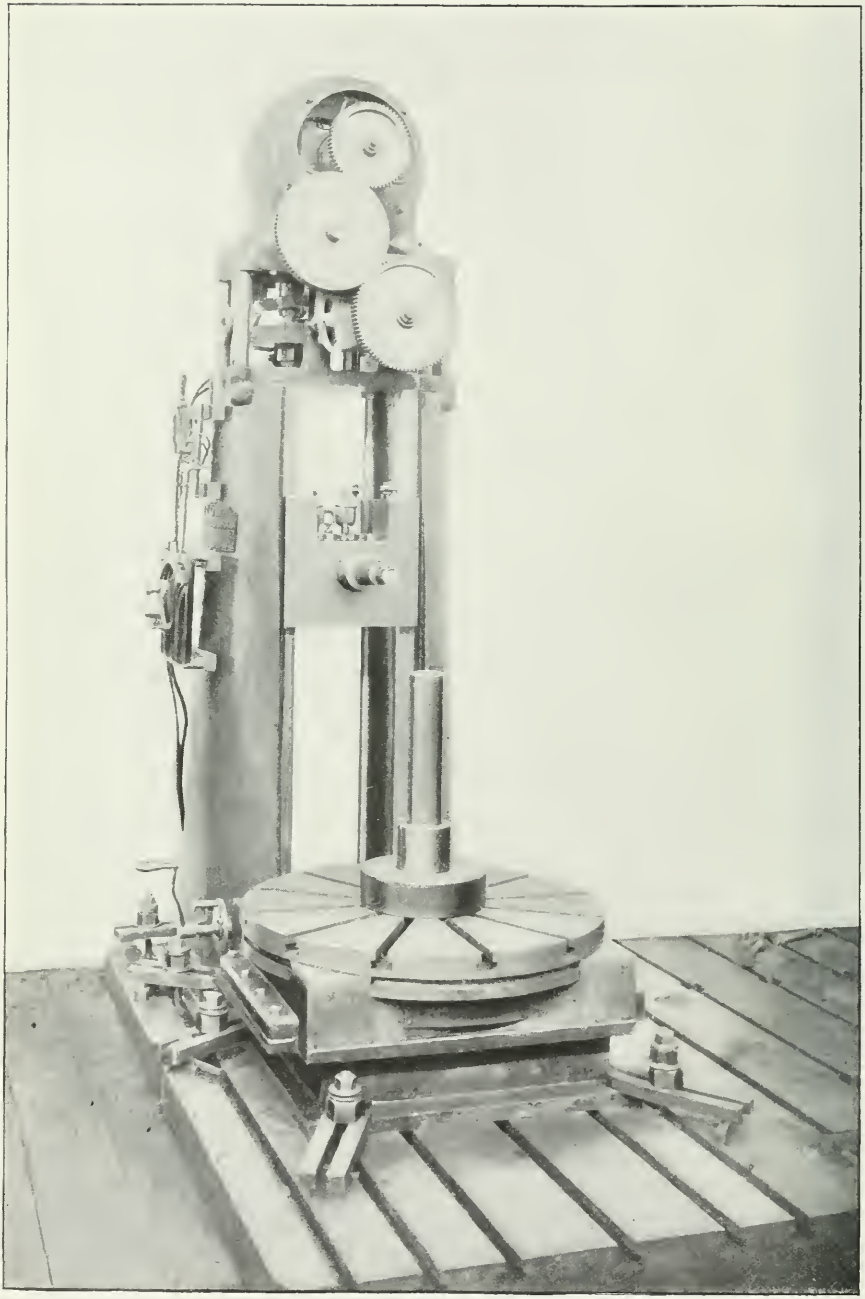
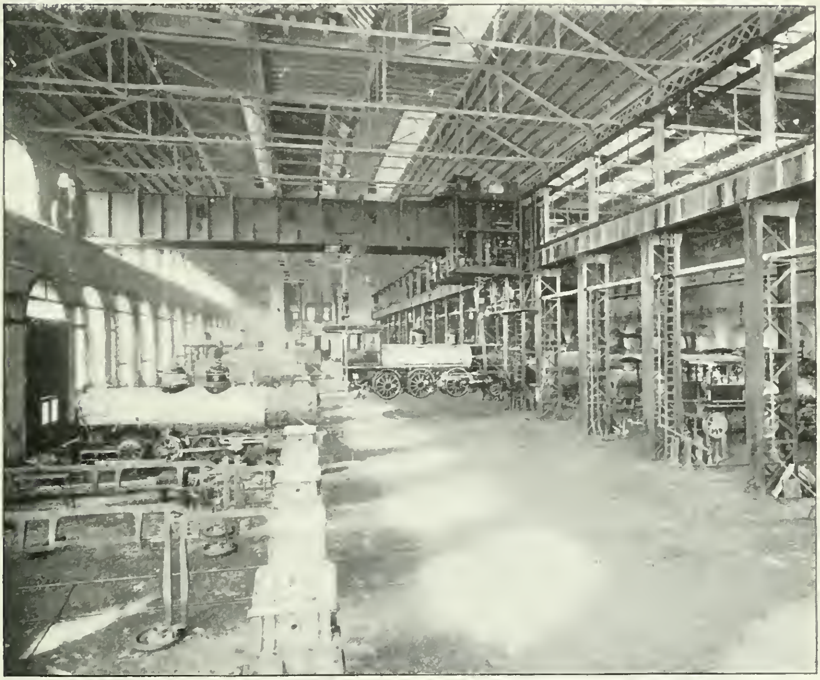


FIG. 4. PORTABLE COMBINED BORING AND MILLING MACHINE, DRIVEN BY 3-H. P. MOTOR.



ELECTRIC CRANE HANDLING A NEARLY COMPLETED LOCOMOTIVE.
An example of easy internal transportation of heavy machines The view is taken in the erecting shops of the Baldwin Locomotive Works, Phila., Pa., U. S. A.

it is very interesting to follow the peregrinations of a single comparatively simple article. Back and forth it goes from department to department, until, by the time it is completed, it has really been an extensive traveler leaving a long trail of tickets and receipts behind it. I once computed that a small bit of machinery had wandered about its factory yard about three miles, mostly in push carts, before it finally reached port in the shipping room. This routine is beautifully systematic, but expensive. Of course, it is necessary to have in every establishment some one who is possessed of a methodical devil, but means should always be at hand to confine his obsession to useful purposes.

A free use of electrical distribution, making it possible to work portable machines almost anywhere and to drive machinery economically all over the works, enables one to get rid of a vast amount of useless transportation. If the product is very varied, departments which are fairly independent may often advantageously be set apart and worked under the close supervision of their own foremen, charged with complete control of the work and held responsible only for results. With portable tools at hand the machine work can be done very efficiently, and, what is of more importance, it can be done without a division of responsibility. To get a vivid idea of the other sort of thing, conceive a ship-yard in which every half-finished hull awaited its turn for transportation to the rivetting department, thence to be borne in triumph to the painting department. Yet, absurd as it seems, the same sort of thing on a smaller scale is part of the daily routine of many a large factory. Some transportation there has to be, and there is now a very healthy tendency to equip all extensive works with electric cranes and tramways that replace hand tackle and push carts at an enormous saving of labor. It is hard to say too much for the valuable qualities of the electric cranes in particular. They are vastly easier to arrange for long runs, and to handle generally, than power cranes of any other sort, and the amount of labor saved is truly prodigious. Take, for example, the 30-ton travelling crane shown in Fig. 5. Although not of very great capacity, it has a very long run and

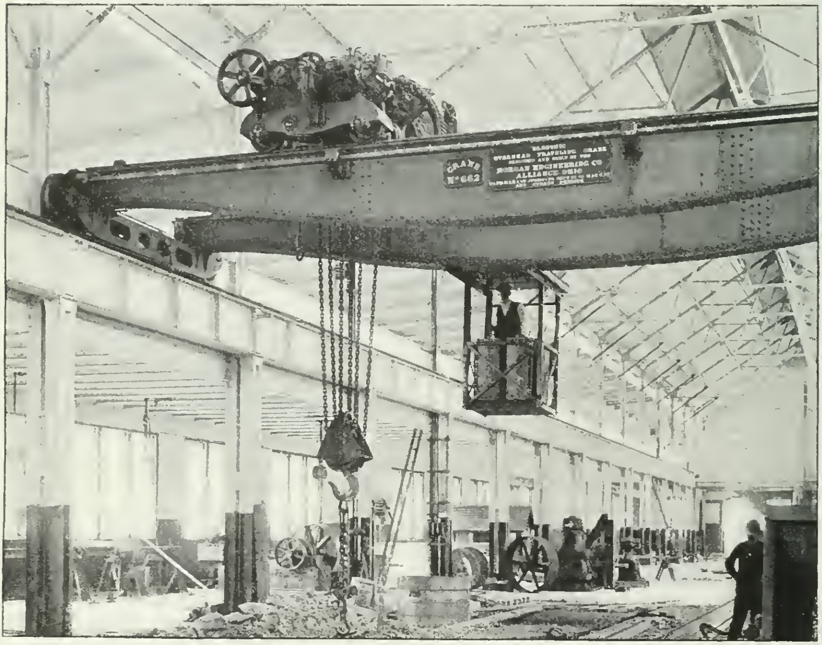


FIG. 5. ELECTRIC CRANE WITH LONG RUN, QUICK TRAVEL, AND ACCURATE CONTROL.

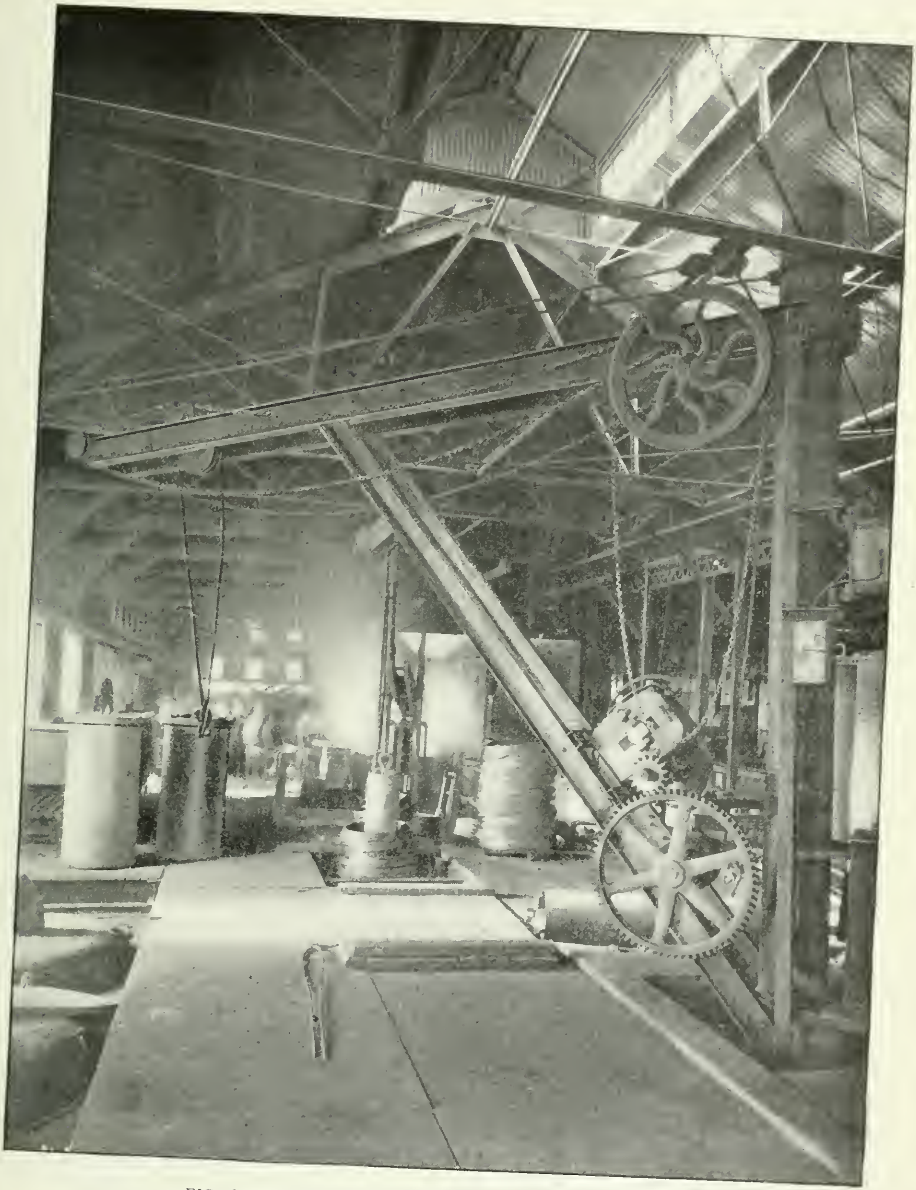


FIG. 6. ELECTRIC JIB CRANE IN AN ANNEALING MILL.

An instance of the style of installation which characterizes American plants, and which, in the iron and machinery trades, has so rapidly brought the United States into successful competition with the old world.

most accurate control, so that it is only a few minutes' work to land the heaviest piece of machinery the crane can handle in any part of the huge erecting shed.

Fig. 6 shows a large crane of the swinging type in the annealing room of a big wire mill. In works where heavy engineering work is done these and similar machines are coming into extensive use, and much of the economic development in the American steel industry is due to the promptness with which such auxiliaries have been installed. A mill with the appliances of a decade ago has a very small chance in competition with mills where ample power, under perfect control, is available for the quick transport and manipulation of every billet that goes through the works. It is the old story of hand labor, or crude appliances, against the most facile of motive powers applied with consummate skill. To such a contest there can be but one issue

Almost weekly some new way of using electric power to replace manual labor is brought to notice, and the progressive manager keeps track of them, adding one or another to his equipment as it seems advisable. Now it is some new form of rapid lift, now a useful application of one of the electric welding processes, or again a special machine to cut down the labor in some simple process. All these come as corollaries, once granted the main proposition that electric power is at home in the works. As a whole, manufacturing establishments of the older sort are full either of small engines using 50 to 100 lbs. of steam per horse-power hour, or of belting and shafting always ready to consume power. Under such circumstances, the centralization of power generation alone is a very great saving. It is the old story of large units well loaded against small units under-loaded or used intermittently. The economy of the process is sufficiently attested by the thousands of horse power in electric motors operated in every large city, bringing power, too, from central stations, distributing current over widespread and costly underground systems at a good profit. While a plant in a single large works cannot turn out current at as low a figure as a big central station, the cost of distribution over the comparatively small distances involved is much less than in central-station practice, and power can be supplied to motors at a rate that means a very great annual saving. The first cost of the change from isolated engines to a central power plant and motors is, of course, considerable; but in the long run it pays. In one case investigated by me a clear net saving of $50,000 to $60,000 per year over all expenses, including interest and depreciation, could have been secured by the outlay of $200,000. The plant in question has recently been installed on a somewhat smaller scale than that indicated, and the proportionate saving bids fair to verify the figure just given. Cases of this sort generally involve both the advantages of power production on a large scale and those attending the abolition of shafting and belting. No general rule as to the amount of saving can be given. As regards that due to increasing the directness of the actual drive, it is not uncommon to save one-fourth to one-third of the total power. The saving due to centralization is generally much greater than this, but of very varying magnitude, depending on the size, nature, and distribution of the units replaced. In working on a large scale, as in engineering works covering a considerable area, the cost per horse-power hour actually used can, however, not infrequently be halved. Wherever the total capacity of the prime movers is several times that of any one, economy indicates centralization, and the more numerous and smaller the separate units the greater the gain is likely to be. Of course a central boiler plant is frequently used, which is a material gain over separate boilers and engines; but, even neglecting the losses due to condensation in distributing steam, every horse power delivered from a small engine, of the sort usually found scattered about large works, means the consumption of two to four times the amount of steam needed to deliver the same brake horse power at the same points *via* the double transformation to electric current and back again. So much for the economy in consolidating the power production, aside from all the gains in shafting and belting, and those other less accurately defined, but most important economies in improving the methods of work and dispensing with manual labor. These last are of far greater interest to the mechanician than the mere distribution of power, and through them lies the road to future economic developments.

The saving which can be made by utilizing cheap power, electrically transmitted from distant water powers or coal mines, lies somewhat outside the limits of the present topic; but in many localities it must be seriously taken into consideration. Both in America and abroad good progress has been made along this line, and perhaps the most notable examples are the transmissions to the works of the General Electric Co. at Schenectady, N. Y., and to the Mercur stamp mills at Telluride, Colorado, in the United States and those of the Oerlikon works and the famous works of Escher, Wyss & Cie, both near Zürich. There are many other examples, of course, but these are especially striking. Of course there are plenty of cases of such transmissions on a small scale, or as a part of a large transmission system devoted to general purposes.

Aside from ordinary power work, there is much to be said for the practical advantages of electric lighting in all large establishments. Good lighting during the short days of winter, and on night work, is as essential to first-class results as are proper tools. A dingy, ill-lighted shop means a general sentiment of shiftlessness that cannot fail to react upon the workmen, quite apart from its actual inconvenience. Where a large shop electric plant is available, plenty of light and good light can be had at a very reasonable cost. The enclosed arc light is of particular value for this work, since not only does it require little attention, but gives a very soft and well distributed illumination. It is not saying too much to lay down the rule that the naked arc should never be used for interior lighting. It is far too glaring, and casts too sharp shadows for satisfactory results. Incandescents are exceedingly good in their way, but are unsatisfactory in large shops and when brought close over the work should be shaded and reinforced by considerable general illumination. Out of doors, bare arcs with reflectors to diffuse the light often facilitate night work astonishingly and save their cost many times over.

To sum up the case, experience now gathered from many large shops for some years past has shown: First, that by distributing power electrically and doing away as far as practicable with idly-running and under-loaded shafting, the gross amount of power needed for a given output is considerably reduced. Second; that by centralizing the power plant and distributing electrically, the net cost of the power for the given output is greatly decreased. Third; that by electric driving applied to special and portable tools and to means of transportation, the labor item in the cost of manufacture falls off to a notable degree; and finally, that special electric processes and electric lighting greatly facilitate the manufacturing operations and not only improve the output, but better the general *morale* of the shop, on which in the last resort, depends the ultimate economy of manufacture.

Dr Bell. in the paper presented above, shows very clearly the great gains which have been and may be effected by electric applications in the centralizing of power In a second article, now in preparation. he deals with the remarkable, and apparently paradoxical, corollary—that electric transmission and electric driving enable *distribution* of industry, through putting the economies of centralized power generation at the command of the small power user. THE EDITORS.

THE OUTLOOK IN THE AMERICAN IRON INDUSTRY.

By Archer Brown.

A RISE of 100 per cent. in six months in the price of a commodity so universally used as iron is calculated to startle the world. It requires little sagacity to see that if present values are to be maintained for any length of time, a new basis of all industrial operations is rendered necessary. Will it last? How can it last? Assuming that 1898 prices netted cost to the makers, it would seem to follow that there is 100 per cent. profit in the manufacture to-day. Millions of capital are eagerly seeking investment where one tenth of that return can be assured. Why will not that capital rush in, start the idle furnaces and mills, build new ones, and quickly break down the markets by over-production? Again, will not new undertakings be checked by the high cost of structural steel, machinery, rolling stock, electrical equipment and the like, so that the great demand will soon begin to fall off, and the makers find themselves with more iron than customers?

Questions like these are universally asked by those who produce as well as by those who consume. The answer reaches far into economics—labor conditions, relations with foreign nations, transportation facilities, the physical limitations of mines, waterways, etc., the staying quality of the farmers and laboring masses in their power to buy needed things and pay good prices for them, the rapid increase of gold coinage in the world, and last, but not least, the capricious but powerful factor in all commerce and industry—human nature.

The facts of the rise in prices are fresh in all minds. In the first week in December, 1898, the larger interests in Alabama felt that the better demand warranted adding 25 cents per ton to the price of $7.00, then prevailing for No. 2 foundry pig iron f. o. b. cars Birmingham. It is a somewhat curious fact that, while Alabama produces less than a tenth of the pig iron made in the United States, it is her admitted prerogative to fix prices for the whole market. This is due, doubtless, to two causes. It is the cheapest center of production of raw iron in the world, and its product reaches nearly all consuming markets of the United States, and even of Europe, on more nearly equal terms than that of any other district.

There was not much confidence in the improvement at first. There had been several false starts since the Baring failure in 1890 and the memorable panic of 1893, and nothing was more deeply fixed in the minds of producers and consumers alike than that the era of low prices was here to stay. Here and there a man had a memory and used it. But, for the most part, furnaces and mills sold freely on the first slight advance. When the price was up fifty cents a ton on pig iron and a dollar on steel billets and bars, furnace and mill owners joyfully took heavy contracts. When another dollar was added, along in January, many of the strongest and most conservative concerns in the United States booked their output for three, six, and even nine months ahead. At this writing (September) tens of thousands of tons of material are still going forward on these low-priced contracts. And to the honor of the trade be it said that, almost universally, the fulfilment of these low-priced orders is given preference over newer and highly profitable business. Here and there an unscrupulous concern has found the temptation to side-track the cheap business too great to resist, but these are rare exceptions to the general rule of good faith and business honesty.

The incredulity of the trade as to the genuineness and extent of the improvement had one conspicuous illustration in the highest quarters. The Lake Superior ore interests are counted the corner stone of the American iron and steel industry. The owners and agents centering in Cleveland, Pittsburg, Youngstown, and Chicago, thought prudence dictated a conservative policy, and opened their books in February at agreed prices averaging scarcely 25 cents a ton above the very low range of 1898. The ore was snapped up almost in a day, and before the bewildered sellers could tell what had happened, the vast product of all the Lake Superior ranges was sold for deliveries extending to July 1st, 1900. Stockholders of mines and other critics, wise after the facts, have wondered at a policy so very conservative towards the mine owner, and so highly liberal to the furnaces. In the light of subsequent events, it was a huge mistake. But it must be remembered and emphasized that, as late as March, only a man here and there in the whole trade showed, by his acts, his faith in the large improvement which was so rapidly to follow.

The following table will show the change that has taken place in prices of a few of the leading products in different markets of the United States:

PIG IRON.	Sept. 6, 1899.	Aug. 23, 1899.	Aug. 2, 1899.	Aug. 31, 1898.
Foundry Pig, No. 2, Standard, Philadelphia	$22.00	$20.75	$20.25	$10.50
Foundry Pig, No. 2, Southern, Cincinnati	19.25	18.50	18.00	9.50
Foundry Pig, No. 2, Local, Chicago	21.00	20.50	20.00	11.00
Bessemer Pig, Pittsburgh	23.25	22.50	21.25	10.00
Gray Forge, Pittsburgh	19.50	18.50	17.75	9.35
Lake Superior Charcoal, Chicago	24.00	23.00	22.00	11.50
BILLETS, RAILS, ETC.				
Steel Billets, Pittsburgh	37.00	36.00	34.00	16.00
Steel Billets, Philadelphia	39.00	38.00	36.00	17.75
Steel Billets, Chicago	....	36.80	36.80	17.00
Wire Rods, Pittsburgh	44.00	44.00	43.00	22.00
Steel Rails, Heavy, Eastern Mill	32.00	32.00	30.00	18.00
Spikes, Tidewater	2.35	2.30	2.00	1.40
Splice Bars, Tidewater	2.05	2.00	1.90	1.05

Without going into a tedious array of statistics, a few leading facts and figures are necessary to an intelligent knowledge of the problems outlined in the first paragraph of this necessarily general sketch. The history of the iron trade in the United States shows a persistent tendency to double consumption and production every decade. When the figures were small, in the years preceding and immediately following the civil war, it seemed no great thing to double in ten years. But when the statistics have grown to huge proportions, leading all the countries of the world, it seems like a geometrical ratio impossible to maintain. But if it is not made in 1900, it will only be because of physical limitations placed on production, not because the demand is wanting. The following figures will help illuminate the subject:

PIG-IRON PRODUCTION OF THE UNITED STATES BY DECADES.

	Gross Tons.		Gross Tons.
1859	750,559	1880	3,835,191
1860	821,223	1889	7,603,638
1869	1,711,285	1890	9,202,703
1870	1,665,178	1898	11,773,934
1879	2,741,852	1899 (estimated)	13,000,000

Stocks of pig iron in furnace and warrant yards in the United States in 1897 exceeded 1,000,000 tons. September 1, 1899, they had been reduced to about 160,000 tons, as the following figures show:

April 1, 1897	1,092,113
April 1, 1898	814,951
April 1, 1899	302,628
Sept. 1, 1899 (estimated)	160,000

It appears from Mr. Swank's tables that the consumption of pig-iron in the United States in 1898 averaged a little over 1,000,000 tons per month. In 1899 consumption is limited closely to the output, and may therefore be estimated at 13,000,000 to 13,500,000 gross tons for the year.

Going back now to the question "Will it last?" Frankly, it must be admitted no man knows. It is not given to mortals to unlock the future. War, famine, pestilence, Bryanism, may intervene and upset all calculations. But the wise man faces the facts as they are before him, and builds his judgment on these, discarding optimism, pessimism, preconceived theories, and even tradition. There were never better settled or apparently sounder commercial traditions in the past than that dollar wheat, ten-cent cotton, and ten-dollar pig iron (at Birmingham) marked the bottom limits in the great staples; but we became familiar with values scarcely more than half these, and men lived and prospered.

The simplest and largest fact in the present situation is a demand greater than the supply. What makes the demand? What limits the supply? The demand is great because seventy millions of people have pinched and economized for six or eight years, and now are quite able to buy, and what is of more consequence, are in a mood to buy. They have made the old stove answer, worn out the harvester and threshing machine, postponed the building of the county bridge, got along with the old stationary engine or lathe, put off the purchase of needed rolling stock for the railroad, hesitated to try conclusions with England in the building of ships, and generally have waited for the return of what is known as "good times." Now they want to replenish, from the sad-iron to the locomotive. Will they stop because prices advance? No, they will not. Here enters the element of human nature. Confidence breeds confidence. Distrust feeds on itself. Two years ago the great railroads of the United States could have renewed much needed equipment at about half the cost that to-day they do not hesitate to pay. Did they do it? It is notorious that the richest hesitated most. An amusing illustration is the case of a master mechanic of a great road whose requisitions underwent the usual cutting in two in the middle when they reached the management. Among the track and shop supplies needed was a large belt for an engine. When it came it had suffered the usual pruning, and was just half long enough to reach. The writer will not soon forget an effort, in the summer of 1897, to find a buyer in New York for 100,000 tons of Alabama pig iron which a large interest was willing to close out at six dollars a gross ton, duly stored in a warrant yard—a price unprecedented in the history of the world. Not one of the great banking houses of capitalists dare fare the perils connected with such a proposition, though money was ruling at three per cent., and nearly free storage on the material was guaranteed. To-day almost any bank in New York would lend fifteen dollars a ton on it, and scarcely ask a question.

Buying, therefore, will not stop because prices are up. The railroads must have enormous additions to equipment, or lose the great harvest of profitable traffic. The millions of farmers will buy their agricultural machinery, stoves, carriages, and pianos, because crops have been good for three years, fetch good prices, the mortgages are paid off, and there is money in bank. Electrical equipment will not stop while street railways and lighting companies make large earnings, merely because dynamos and rails are dearer. Cities and towns will put in needed water and gas pipe without much regard to whether the cost is $18.00 or $28.00 a ton.

It is perfectly true that some new enterprises, that otherwise would take shape, are deferred because cost is found to exceed engineers' estimates. But this builds a reserve demand that will come in to support the market in the future. In high steel buildings, in large cities, for example, there is a distinct limit to prices that may be paid for materials without bringing the cost to a point beyond earning ability. The merchant marine can not be built up as rapidly from American ship-yards on $28.00 steel as on $16.00 steel. But these are but eddies in the main current.

The real factor in lowering prices will be in increased production, not diminished demand. How fast can the output of the furnaces be increased? I say not over fifteen to eighteen per cent. per annum. There was incredulity in as high quarters as Mr. Swank, Secretary of the American Iron and Steel Association, when this prediction was made early in the year. For were there not a couple of hundred idle blast furnaces in the country ready to blow in the moment profitable prices were reached? Would American capital or energy hesitate where the reward was so great?

It may be profitable to analyse the factors which operate to restrict profitable production. In a situation like the present they are clearly revealed, and many fine theories are upset by common physical facts. Few people, who have not actually run a blast furnace, realize what it means to fill the capacious maw of one of those monsters with raw material. A stack of 200-tons daily capacity, running on 50 per cent. ore, must have delivered to it each day something more than 400 tons of ore, 250 to 300 tons of coke, according to the character of the metal required, and over 100 tons of limestone, besides sand, coal, and minor supplies—say 900 tons raw materials. Add the 200 tons of pig-iron product shipped out, and we have a daily freight movement of 1,100 tons, taking no note of the disposition of the slag. This is 55 carloads of 20 tons each. The mining of the ore requires the labor of 150 to 300 men, according to location; the coal mining, coke making, quarrying of limestone, and transportation, at least 300 more. The furnace itself employs about 150 or more hands. It will be seen, therefore, that starting up a furnace of ordinary capacity calls immediately for the labor, from first to last, of nearly a thousand men; for the use of at least a thousand railway cars and many locomotives; for perhaps several steamers and vessels on the lakes; for capital, from the mines to the pig iron, of one to two millions of dollars, and last, but not least, for a high order of managing ability, the scarcest of all scarce commodities, in times like these.

To use a concrete illustration, the Tonawanda Iron & Steel Co., located near Buffalo, operating two furnaces only, must unload at its docks one good sized ship-load of ore every day during the entire season of lake navigation, or fail to get down its needed supply. Another striking evidence of what it means to bring down the ore for the furnaces now running which depend on Lake Superior mines may be witnessed any day on Detroit River, where the loaded steamers and sailing vessels down, and the light craft up, crowd so close upon each other as almost to touch. Still another illustration, at hand as I write, is that of a small charcoal furnace on the lower lakes, needing about 80 tons a day, but unable to start because transportation could not be had for it. To add 1,000,000 tons, or say 10 per cent. to production, means the organizing, equipping, and starting of twenty such operations as described in the preceding paragraph.

The easy theory, therefore, that production can be turned on, as from a faucet, when profits are high, does not fit the facts. It is needless to say that every nerve will be strained to get into operation at the earliest moment the few existing idle plants, but those who base their calculations on an increase of not over 12 to 15 per cent. per annum in the next two or three years, will not go far astray.

It has not escaped notice that in all the present excitement, little is heard of organizing companies to build new plants. Each of the great consolidations is planning additions to capacity, but there are few schemes to develop idle property, as was the case about 1890. There are reasons for this. The building of furnaces to sell town lots was generally disastrous. The impression is still abroad that there is a large reserve idle capacity. But the main factor in restraint is that, under present conditions, it would require at least a year and a half to build a good modern plant; the cost would be 50 per cent. greater than a year ago—and who knows where iron would be when the furnace was ready to start? The wisdom of the policy of building and enlarging in the bad times, followed for many years by Krupp and Carnegie, is demonstrated in a period like this.

What of the export trade? It is generally believed that this new factor is the all important one in sustaining American markets. Taking the iron and steel manufacture as a whole, I believe this to be true. But so far as ores, pig iron, and even steel billets are concerned, the movements has never reached 5 per cent. of the product of the United States and probably will not for years to come. Radical changes in the freight and labor situations must occur before America can capture English and European markets with crude iron. She is shipping liberally, it is true, and will continue to ship, for prices in Europe will always be regulated pretty closely by those in the United States.

But it is in the finished forms where American victories will be won, as they are now being won. In locomotives, wood- and iron-working machinery, agricultural machinery, nails, wire, bicycles and a hundred other lines, American inventive genius, great productive capacity, modernized plants, superior business organization, etc., will maintain and doubtless increase the great total of $80,000,000.00 reached last year in her iron and steel exports. The effect of this great and growing foreign demand is sensibly felt in every department of the trade.

The belief is widespread that exports from the United States must suffer a sharp check, if not come to a full stop, unless prices in America recede. This is a natural, but not well grounded, view. It assumes that the markets of the rest of the world go their way, irrespective of what the United States does. That was formerly the case, but it is so no longer. The world is now knit closely together in its industrial and commercial as well as its financial fabric. Influences that affect one nation are soon felt by the others. England and Germany were in the midst of industrial prosperity two years before it was felt in

America, but now that she has responded, the added stimulus is felt over there. We think it phenomenal that the mills and furnaces throughout the United States should have their product booked half through next year, but in Germany and Belgium they are already booked all through the year 1900. The great Krupp works at Essen, employing thirty thousand men, are filled with orders until 1901. Germany has nearly overtaken Great Britain in pig-iron product, but is nevertheless importing largely from both England and America to supply her deficiency. Great Britain shows a slackening in her shipbuilding industry, but her export trade in iron is again growing and all her lesser industries are exceedingly active. Prices of iron and steel have risen there almost as rapidly as in the United States. Middlesboro pig that sold last year for 43 shillings has reached 75 shillings and is now a little under 70.

The fact is the great industrial awakening is worldwide. China, India, South Africa, the Philippines, Japan, Russia, and the new island possessions nearer to the United States are full of projects for improvement. They have caught the renaissance spirit. The beginnings are small, but they suggest immense future possibilities. They want steam railways, electric lines, electric lighting, water-works, locomotives, machinery, bridges, etc., and it scarcely seems probable that having felt some of the benefits of modern progress, they will decide to turn back. America has shown her ability to compete with the other industrial nations for this trade, and will continue to get it in increasing quantity.

The world's consumption of iron grows in geometrical ratio. In 1740 it did not amount to one pound for each inhabitant. In 1856 it was about 17 pounds per capita. In 1890 it was 35 pounds per capita. In 1900 it will be probably 60 pounds per capita. The following table of consumption in the different countries proves the claim of iron to be the barometer of civilization:

	1856.	1890.
Great Britain	144 pounds	250 pounds.
United States	117 "	300 "
France	60 "	175 "
Germany	50 "	175 "
Belgium	70 "	175 "
Sweden	30 "	100 "
All the rest, say	6 "	12 "

In this connection the growth of the world's production of pig iron is interesting. In round numbers, this has been as follows:

In 1856	6,600,000	gross	tons.
In 1867	9,300,000	"	"
In 1878	14,100,000	"	"
In 1889	25,000,000	"	"
In 1890	26,500,000	"	"
In 1900, estimated	35,000,000	"	"

Of the last enormous total there is good reason now to believe that the United States will supply 40 per cent.

A word as to the new level of prices. It is too high of course to be permanently maintained. It is too high for the lasting good of this great industry. But we must not be misled by making false comparisons. The conditions reached in the lean years following the panic were abnormal, not natural. Iron was forced to $6 a ton at Birmingham on wages of 90 cents a day for twelve hours' work; on transportation rates that did not return the railroads' cost; and on destruction of royalties, or values of the ore and coal in the ground. The same was practically true in the Lake Superior district. It was simply a struggle for life. Values of great properties shrunk from millions to hundreds of thousands. Labor and capital fled to other fields. America learned great and valuable lessons during this trying experience, among others, how to produce iron more cheaply than has ever been done in the history of the world. Perhaps in the end the experience may prove to have been a blessing. But we must not make the error of supposing that those were normal conditions, and that when we have escaped from them we are on an artificial basis. A sound view is that we are nearer normal conditions to-day than we were when 100,000 tons of $6 pig iron went begging for a buyer in New York. A cent a pound for the best pig iron in the world should not, after all, paralyze the faculties of reasonable persons.

It should not be forgotten that the cost of iron resolves itself substantially into three things: labor, transportation and royalties, or the value of the material in the ground. Labor, the largest item, is up 25 to 40 per cent. in iron making. It is not yet too high for the good of the country. Transportation is up about as much, but who shall say the stockholders of the railroads and steamship lines are not entitled to a few dividends after years of waiting? It is now possible to credit ore and coal mines with something for the materials in the ground. But is it a violent assumption that the great iron and coal deposits of the United States, which are usually counted the foundation of wealth in an industrial nation, are actually worth something and should return a profit to their owners on material mined out? If these points are conceded, the legitimate cost of pig iron in the United States is at least 33 per cent. above the low level to which it was forced in the years from 1895 to 1898. The manufacturer's profit, if any, must be added to this. It is some satisfaction to know also that cost is rising proportionately in other parts of the world. In Great Britain and Germany the increase varies from $2 to $4 per ton, according to kind of metal and locality where it is made. This is due mainly to the steady rise in the price of coke, although ores have advanced and are in short supply.

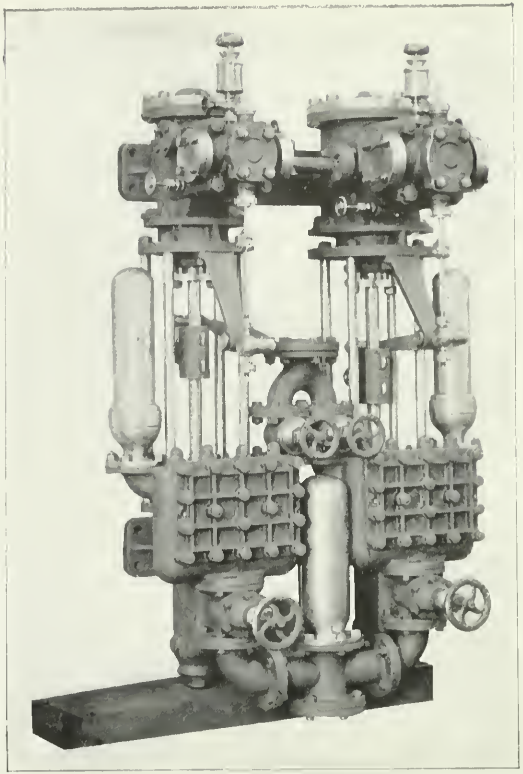
Cautious investors as well as manufacturers quite naturally look forward to the time when collapse will again take the place of boom, and prices will drop below cost of production. Who shall stand against that day? The strong, who expect to survive, are taking extraordinary measures to equip themselves for whatever may happen. The huge consolidations—at least those newly organized—are free from bonded debts, with large provisions for working capital. Some of them indeed are lenders of money in the street. Nearly all have strengthened themselves by ownership of ore mines, coal mines, coke ovens and even transportation lines, so that they are independent "from the ground up." If the time ever again comes for a fight for existence, it will be between giants indeed, and no other nation can resist American inroads. But every observing man has noted, in the instructive years of the past decade, the wonderful tenacity of life of small plants well located and economically managed. Another thing that has not escaped notice is that in the "survival" struggle, there is a marked tendency to equalize conditions in all the different districts. It is a fact capable of demonstration that the best returns on capital during the lean years were not from the great concerns in the most favored locations (barring one or two exceptions), but from certain smaller operations located in districts not usually spoken of as the cheap centers of production. It is a safe assumption, therefore, that, whatever lengths the consolidation movement may extend to, there will be plenty of strong undertakings on the outside that will keep the industry on the sound footing of free competition.

THE USE OF STEAM IN AUXILIARY MACHINERY ON WAR-SHIPS.

By Lieut. John K. Robison.

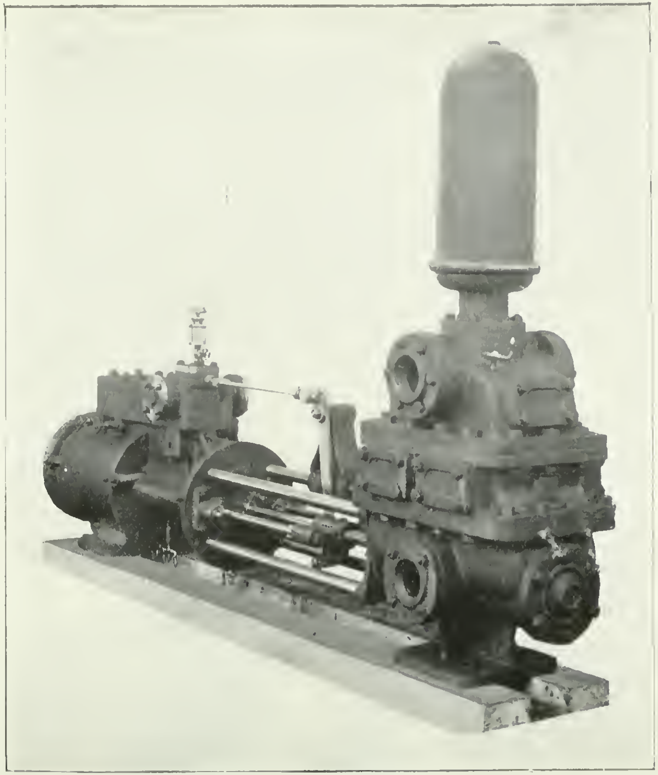
THE article of Mr. Dickie before the American Society of Mechanical Engineers some years ago has been followed by probably twenty others advocating the adoption of a central power-plant for the distribution of electric, hydraulic, or pneumatic power to the many auxiliaries of a war-ship. This question seems latterly to have narrowed down to one as to the advisibility of installing electric motors for operating the auxiliary machinery, these motors to be run in connection with a central electric-power-plant of proper capacity. The suggested arrangement is peculiarly attractive to many engineers, as seeming to be along the line of progress that has been successfully followed on shore. Every one realizes that the conditions on board ship are very peculiar, and that so many elements enter into war-ship design that the whole ship, to be homogeneous, may contain many apparently bad features. Yet electricity is now so extensively adopted in a commercial way, for power purposes, and such great gains have resulted therefrom that, on the face of it, the use of electrically-operated auxiliaries appears more than feasible on shipboard.

Every question of the use of electricity must be decided on its own merits; all the conditions must be duly weighed before a reasonable decision can be reached. What is good practice for a machine shop may be very poor for a silk mill, and electromobiles may be best in a large city but out of the question in localities where there are no facilities for charging the batteries. The conditions obtaining on war-ships differ materially from the commercial conditions in average plants. Weight, an important factor on shore, is vital on shipboard; while capital outlay, with the Government's three per cent. interest charges, cuts a small figure on naval vessels. The question of elec-



VERTICAL CROSS-COMPOUND MARINE FEED PUMP.

One 6 x 3½ x 8 and one 9 x 3½ x 8 simplex, arranged to run together as a compound, or either alone as a single pump. Geo. F. Blake Mfg. Co.

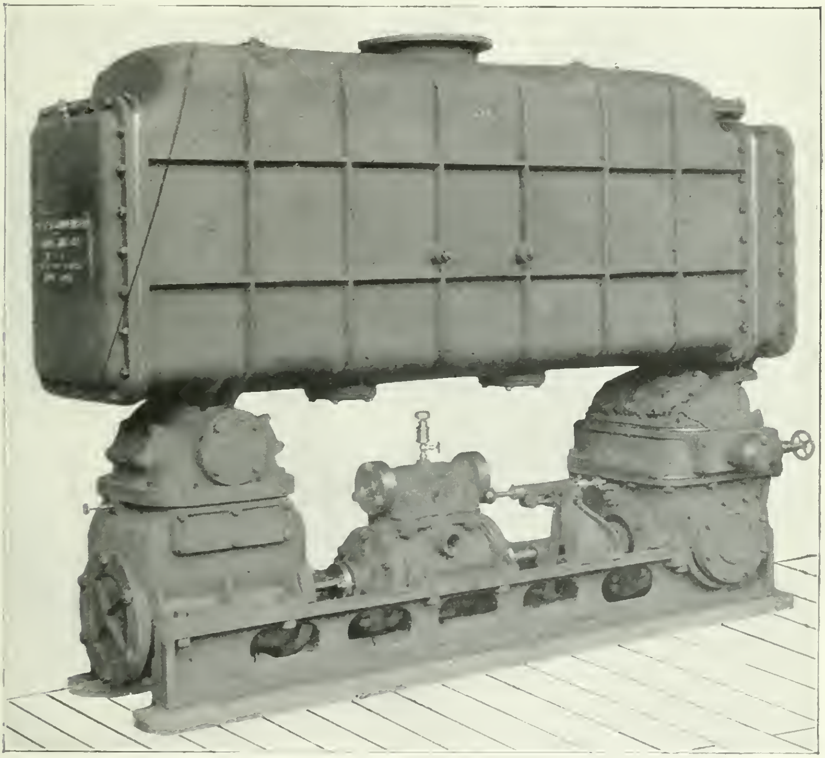


HORIZONTAL TANDEM-COMPOUND MARINE PUMP.

The low-pressure steam cylinder is in the rear, and transmits its motion to the crosshead by the two outside rods. Made by Geo. F. Blake Mfg. Co.

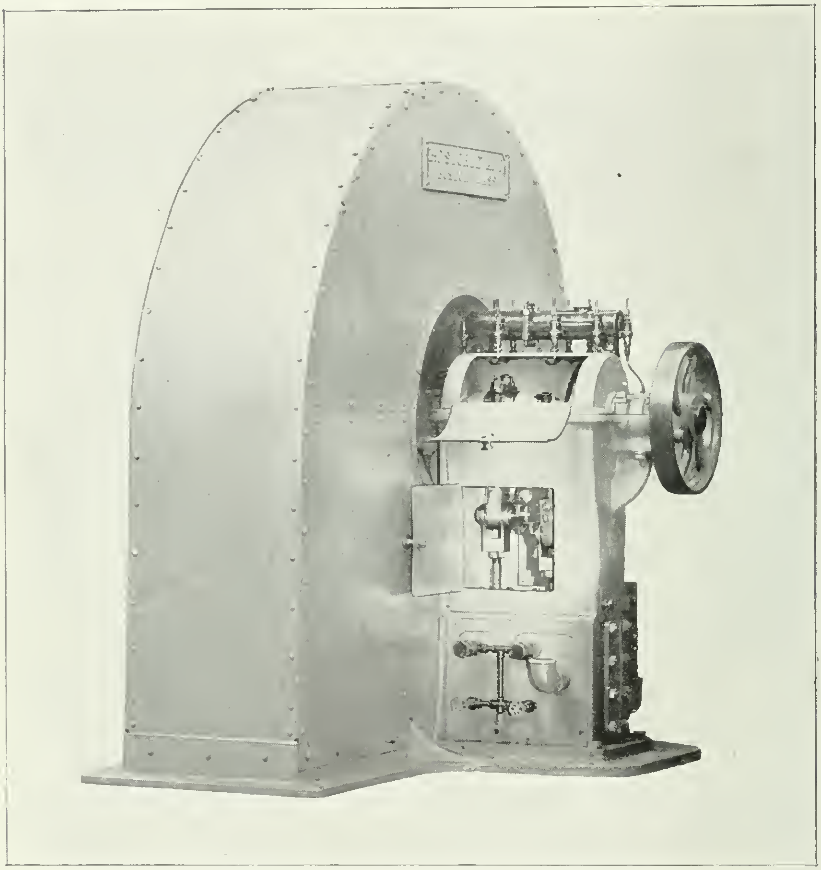
tric auxiliary machinery on shipboard can be answered only after a consideration of all the points involved.

The auxiliary machinery on a battleship includes: air, circulating, feed, and bilge pumps; ventilating and forced-draft blowers; anchor and steering engines; ash hoists, ice machine, turret engines, ammunition hoists, dynamo engines, machine-shop engine, winches, boat hoists, air compressors for charging torpedoes, etc. In short, there is the formidable array of about forty auxiliary engines on a modern battleship, scattered from one end of the ship to the other and in some cases requiring long pipes if operated by steam. These engines are from 2 to 100 h. p. each. The maximum horse power of all is about 1,500. Each machine is usually operated at not more than one-half full power and the maximum power of all the auxiliary machinery in operation at one time, which is in battle, is only about 700 h. p. This



ADMIRALTY SURFACE CONDENSER, COMBINED WITH AIR AND CIRCULATING PUMP.

A form of condenser generally adopted on war-ships when the direct-connected air pump is not used. Made by Wheeler Condenser & Engineering Co.



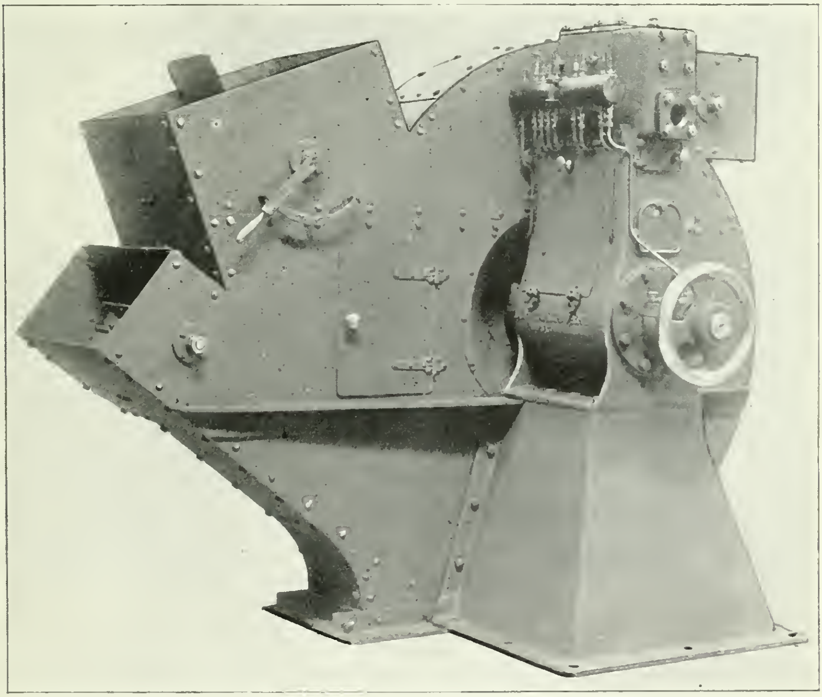
FORCED-DRAFT STEAM FAN, FOR MARINE INSTALLATION.

Made by the B. F Sturtevant Co.

machinery is nearly all of it such as requires a large torque at its highest speed.

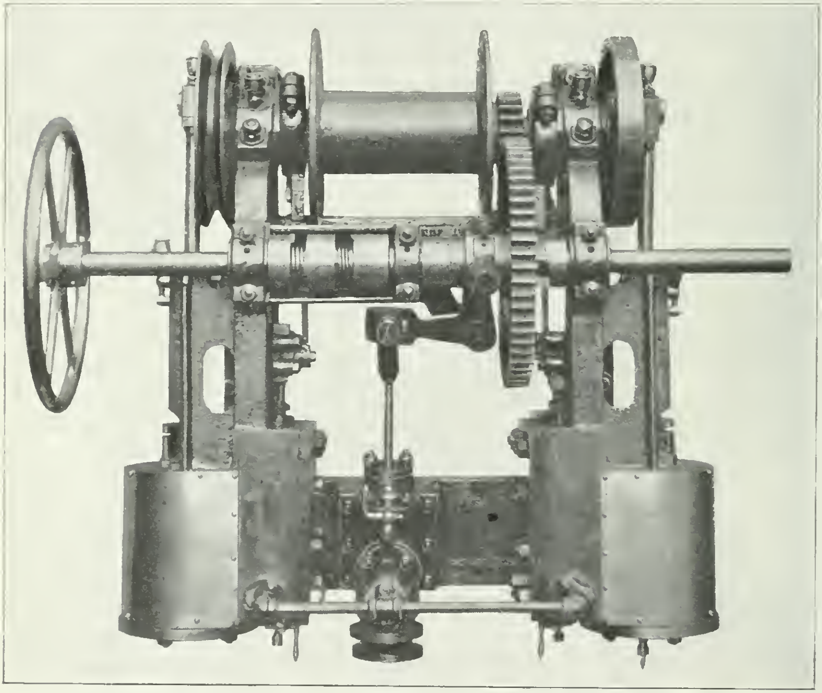
The principal advantages following the use of electricity for the operation of all the auxiliary machinery, aside from economy (which will be discussed later), would be those due to the elimination of the long lines of steam piping now necessary. These are not inconsiderable gains. The long pipes to the anchor and steering engines offer, in time of battle, elements of danger which the use of electric wires would avoid. The steam piping has gaskets to blow out, and besides it makes holes in water-tight bulkheads that can only be kept from vitiating the water-tight subdivision of the ship by great care. The steam pipes heat the ship in the crowded under-water compartments which are hot enough at best. Other advantages of electrically-operated auxiliaries are cleanliness and ease of operation and control. Of course, to attain this ease of operation in a case where electricity is widely used, the generator must have a considerable range of power beyond that ordinarily used; otherwise the starting of an auxiliary engine might involve burning out an armature, and certainly would involve the delay necessary to start up another generating set.

Against these, the great advantage of steam-operated machinery is its security. The introduction of an extra transformer of power, between the boiler and the engine, causes a complication that must always settle the question for such auxiliaries as those necessary to the operation of the main engines—the air, circulating, and feed pumps. Other advantages claimed for steam auxiliaries are that they are simpler, less bulky and, generally speaking, that their repair is easy on board ship and that any defect can readily be found. If overloaded, a steam engine will simply stop. There is no danger of a burnt arma-



STEAM-DRIVEN MARINE VENTILATING FAN, WITH ADJUSTABLE INLETS AND OUTLETS.

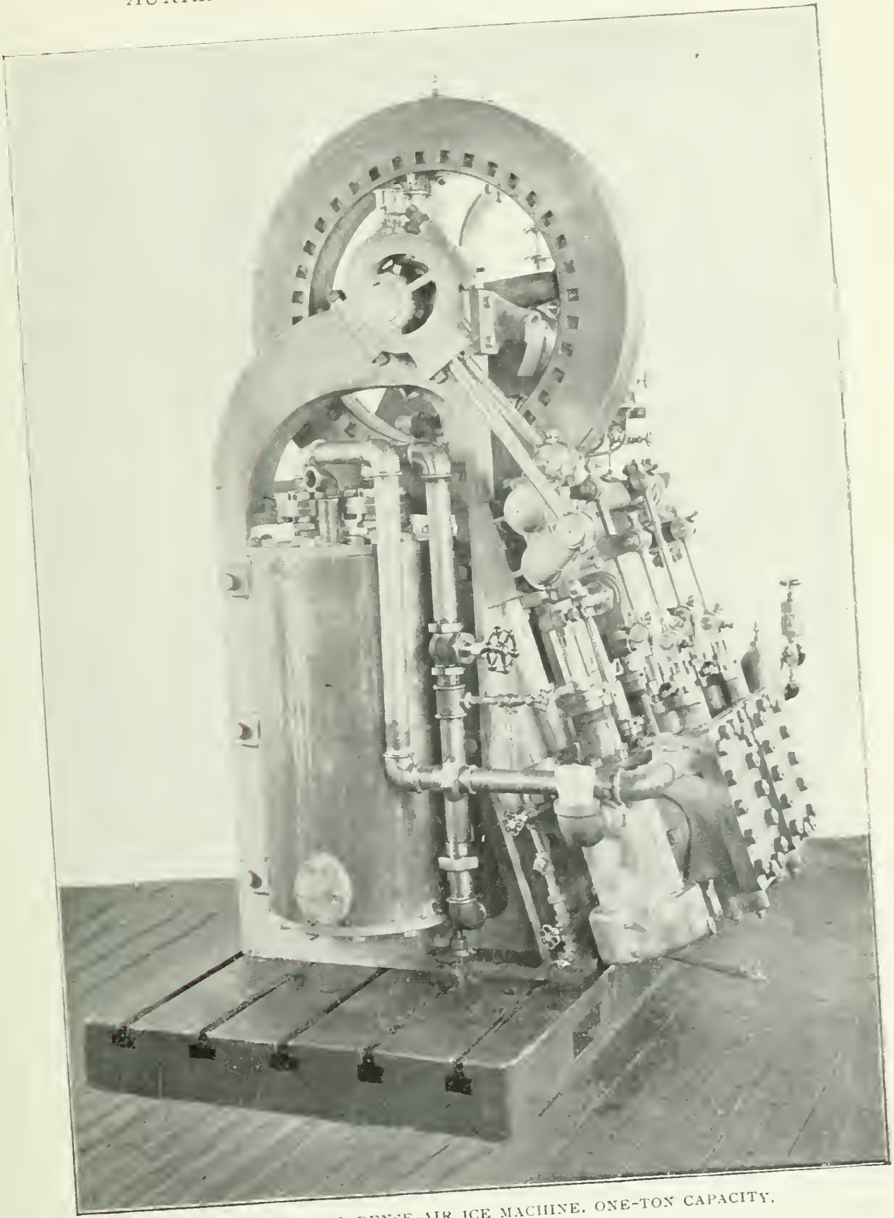
ture, nor even of a blown fuse. It is also asserted, as a disadvantage attendant upon the use of electricity in place of steam, that the motors must be of considerably higher rated horse power if electrically operated than is necessary with steam engines. This every large user of electric motors has already found for himself. In order to obtain the requisite torque at the highest speeds, coupled with delicacy of control at low speeds, electric motors must be of about 50 per cent. greater power than steam engines for the same work.



STEAM ASH-HOIST. IN USE IN UNITED STATES NAVY.

The engine is reversible, and is operated by the hand wheel. It runs as long as the wheel is revolved, and stops automatically when the wheel is stopped.
Made by Williamson Bros.

The foregoing advantages and disadvantages are really minor ones. Summed up, they mean that steam must be used for auxiliaries directly connected with the main engines, but that it would be more convenient to operate other auxiliaries by electricity if proper motors can be furnished. This leaves the question open as to the major part of the auxiliary machinery on board ship, and this question must be

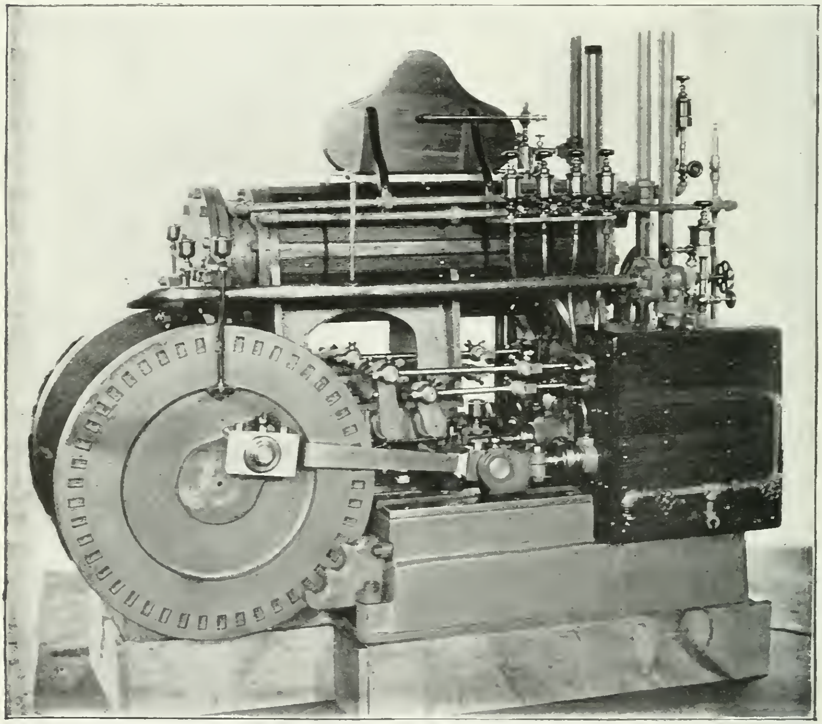


ALLEN VERTICAL DENSE-AIR ICE MACHINE. ONE-TON CAPACITY.
Installed on Austrian cruiser Zenta.

considered on broad grounds and decided in favor of that system which best serves the efficiency of the ship as a fighting vessel.

Mahan has pointed out that the value of any fleet depends upon: first, its offensive power; second, the period during which it can maintain an offensive position; and, third, its dirigibility. In other words, the power of a fleet to injure an enemy may be taken as the product of its gun power, its coal endurance, and its speed. A change from steam to electricity must be made only if it affects favorably one of these three vital elements of war-ship design.

Experience with the electrically-operated turret machinery on the Brooklyn and Massachusetts has shown it to be more delicate in its action than was the steam turret machinery on those ships. This is a matter involving the efficiency of the guns, and the use of electrically-operated machinery for the turrets probably secures a direct addition to the gun power of the ships; for this purpose, therefore, electricity should be adopted. The same good results have been obtained from electrically-operated ammunition hoists, and here, too,

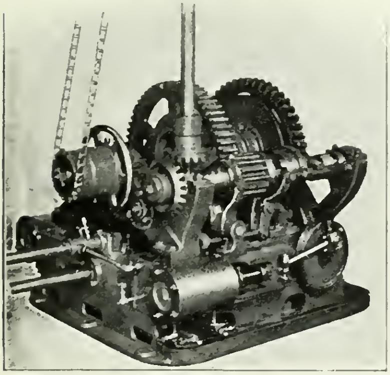


ALLEN HORIZONTAL DENSE-AIR ICE MACHINE.

Type especially adapted for marine installation.

electricity should be used. Of course, electricity is a necessity for the search-lights and for the lighting of the ship. For most of the auxiliaries, however, the question rests upon the economy of the machinery, whether operated by steam or electricity.

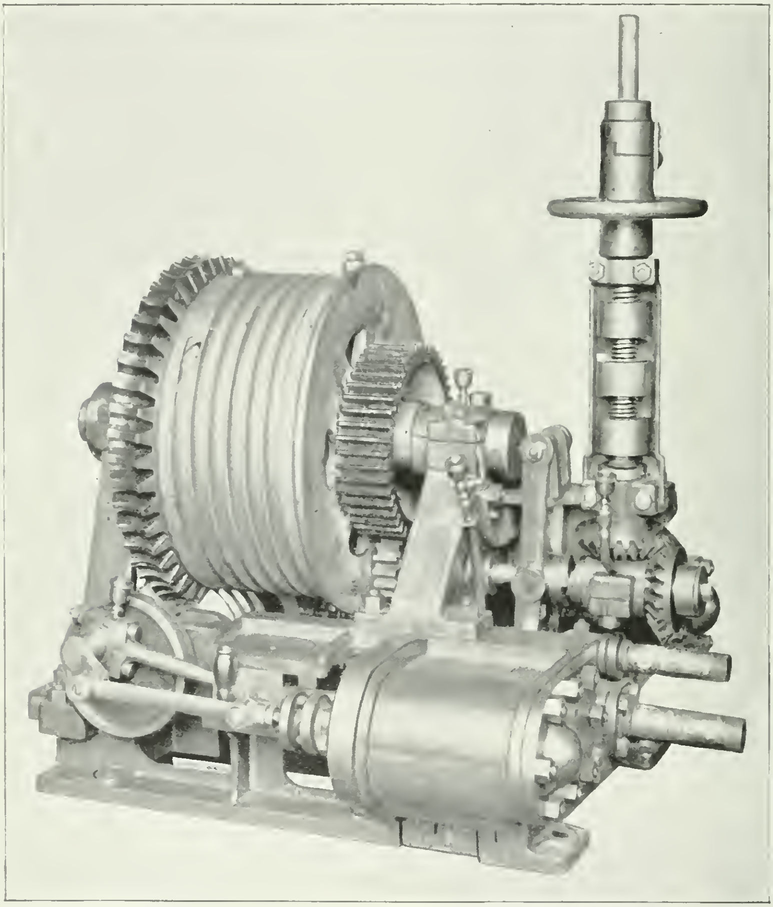
There are two ways of increasing the radius of action of a ship—first, the obvious one, by increasing the bunker capacity; and second, the indirect method of obtaining the same result, by increasing the potential value of each pound of coal through an increase in the economy of the use of steam. The first method is the natural one and the universality of the study to increase bunker capacity is immediately apparent upon comparison of the naval designs of to-day with those of a decade ago. It is worthy of note, however, that an addition to the bunker capacity of a ship is not all net gain. Increase in bunker supply implies an increase in the size of the ship, an increase in the size of the target, in the weight of the hull and armor, and in the weight of the machinery for giving this larger ship the same speed which a smaller one might have. It also involves increase in the weight of coal necessary to drive the ship at this given speed. On the other hand, any increase in the economy of using the coal, or, what amounts to the same thing, any increase in the economy of steam consumption, increases directly the steaming radius of the ship and is a positive gain. Of course, the addition of any device to avoid waste is bound to increase more or less the weight of the machinery of the ship. But if the economy secured is greater



STEAM AND HAND STEERING ENGINE.

The engine is actuated from the hand wheel above, which may be on any deck. The change from steam to hand steering is made by turning the small wheel on the left in the upper engraving. Made by Williamson Bros.

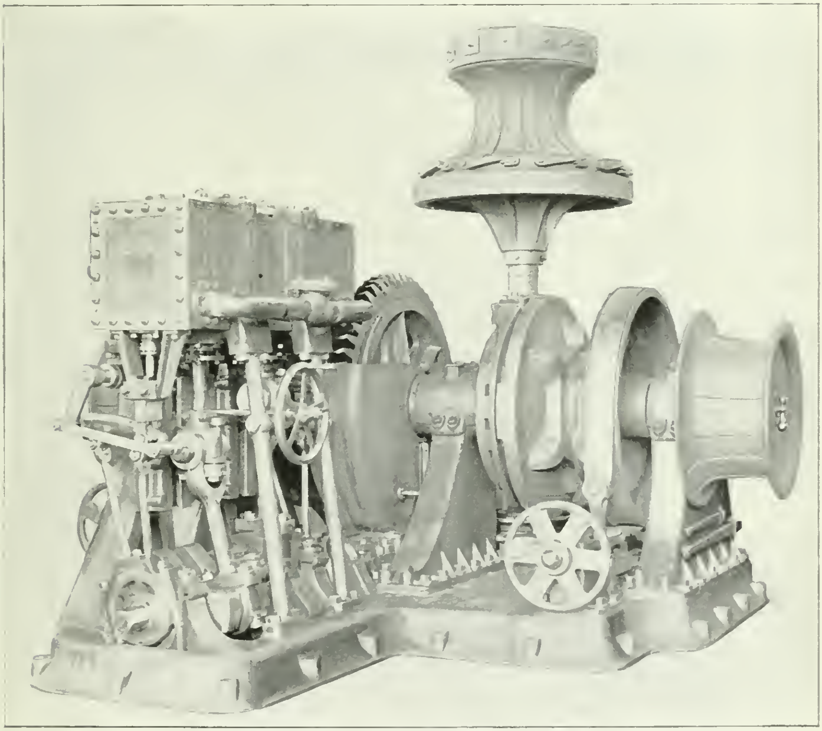
than the weight added, the installation of the device is advantageous. Thus, if increase in the cylinder ratios in naval vessels should be followed by a decrease in coal consumption of, let us say, six per cent., accomplished with an addition of but ten tons to the weight of machinery, it would be advantageous to make this change if ten tons were less than about six per cent. of the bunker capacity of the ship.



AUTOMATIC WORM-GEARED STEAM STEERING ENGINE.

The engine follows, automatically, the motion of the hand wheel. It is fitted with stops to regulate the "hard-over" movement, to prevent the engine pulling against the rudder stops. Made by Williamson Bros

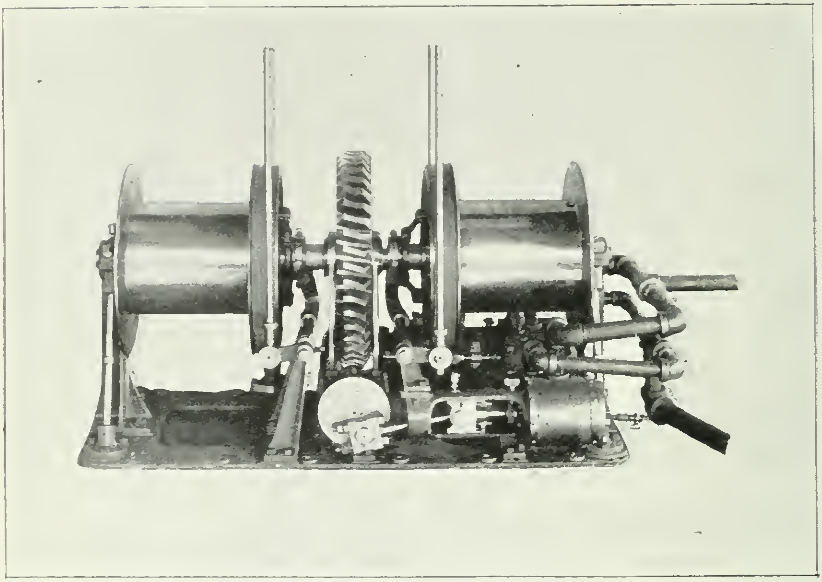
For example, take a ship with a bunker capacity of 500 tons and with a steaming radius of, say, 8 sea-miles per ton of coal, or 4,000 miles. If the addition of 10 tons to the machinery weights increases the economy 6 per cent., we would then be able to make 8.48 miles per ton of coal with 490 tons in the bunkers, or the steaming radius would be increased to 4,155 miles. On the other hand, take the case of a torpedo boat in which it might take the addition of 5 tons to the weight of the machinery to secure a saving of 6 per cent. in the steam consumption, and in which the bunker capacity was, in the first place, but 35 tons. This ship would probably have a steaming radius of 40 sea-miles per ton of coal, or 1,400 miles in all. In this case, the weight added to the machinery would involve an increase from 40 to 42.4 in the number of miles the boat would be able to make per ton of coal, but there would be but 30 tons of coal in the bunkers and the steaming radius would be reduced from 1,400 miles to 1,272.



STEAM WINDLASS FOR 2½-INCH CHAINS.

Installed on U. S. battle-ships Alabama, Wisconsin, etc., by Hyde Windlass Co.

It may be said that the 5 tons could simply have been added to the displacement of the torpedo boat, but even then there would be nearly the same proportional gain in coal consumption if the added



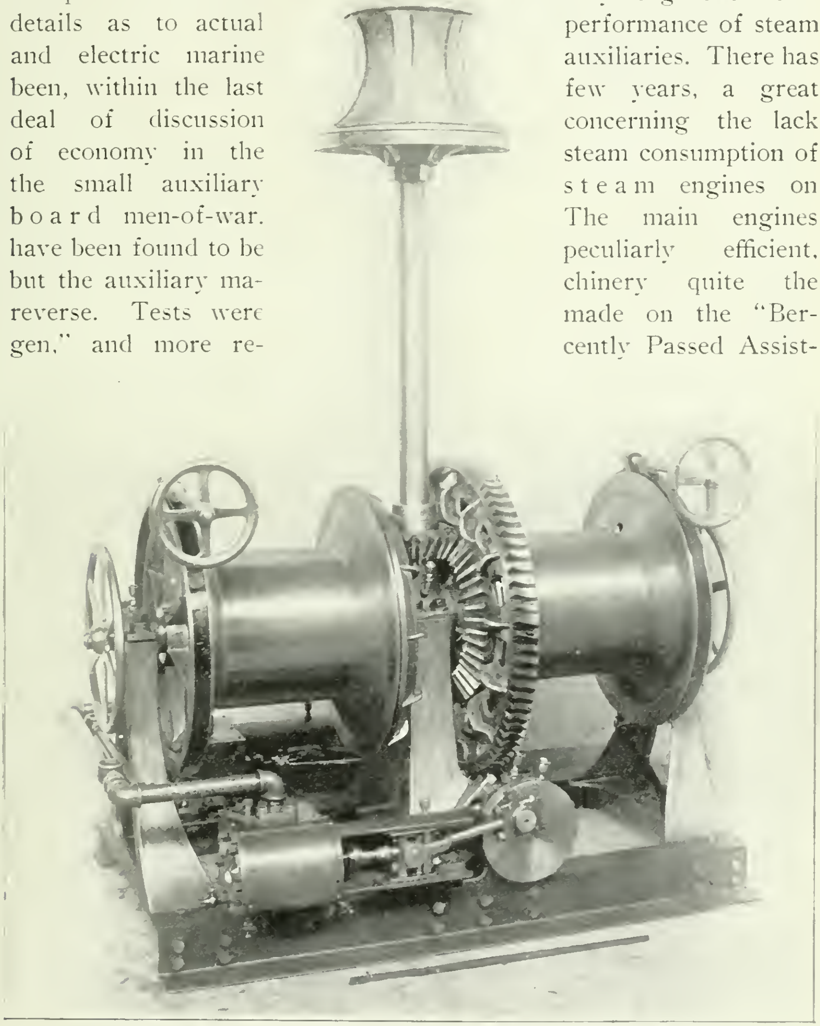
STEAM WINDLASS FOR ¾-INCH WIRE ROPE.

Driven by double non-reversing 4 x 4 engines, and controlled from below or from upper deck. Will take in 12 fathoms cable per minute at 400 revolutions. Built for U. S. torpedo boat Bailey by American Ship Windlass Co.

weight were put on board in the form of coal, and not in that of the apparently economical addition to the mechanical weights. Some of the most obvious apparent economies often involve a real loss—in coal endurance as well as in business.

American designs of war vessels have always been noted for their predominance in gun power, and more than once have American vessels established a record for speed; but I fear that in American naval designs, up to within a very few years, sufficient strength has not been laid upon the vital point of coal endurance—or, in other words, the distance a ship can go without replenishing her bunkers. Sir John Durston, engineer-in-chief of the British navy, states that this is the most important of all the present problems of naval design. While we may or may not agree that the coal-endurance question is to-day paramount, such a statement as the foregoing, coming from an official source of so high authority, demands close attention. At any rate, the particular question as to the extended use of electrically-operated auxiliary machinery must be decided upon the broad ground of economy. Considered from standpoints purely technical and tactical, it will pay us to use electric auxiliaries under the following conditions only:

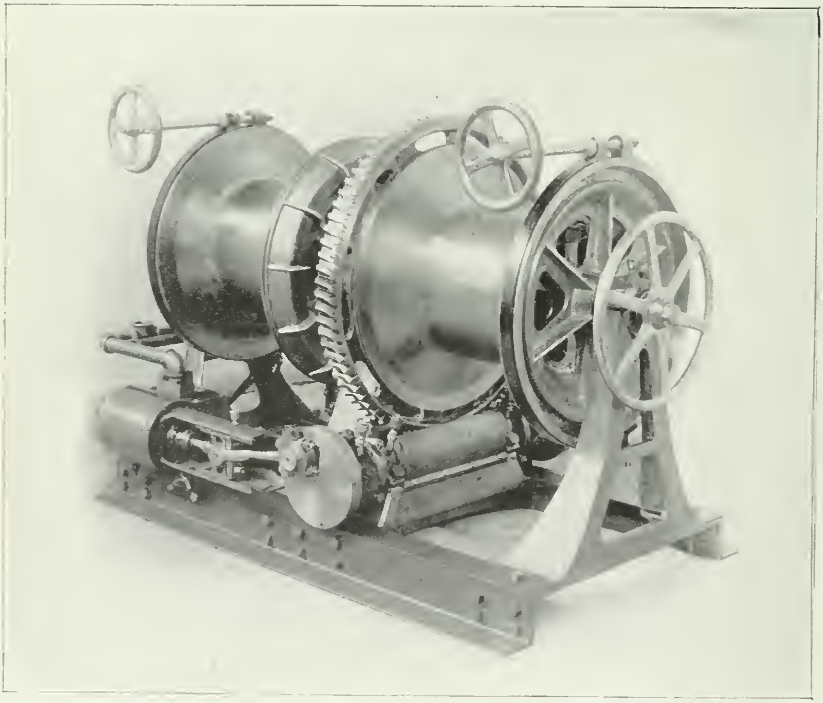
First, electric auxiliaries must be more economical than the steam auxiliaries they replace; second, the difference between the weight of the electric and steam apparatus must not exceed, in percentage of the coal-carrying capacity, the economy incident to the use of electrically-operated machinery. To understand this point it is necessary to go over some details as to actual performance of steam and electric marine auxiliaries. There has been, within the last few years, a great deal of discussion concerning the lack of economy in the steam consumption of the small auxiliary steam engines on board men-of-war. The main engines have been found to be peculiarly efficient, but the auxiliary machinery quite the reverse. Tests were made on the "Bergen," and more recently Passed Assist-



STEAM WINDLASS FOR TORPEDO BOAT, WITH 4 X 4 DOUBLE ENGINE.

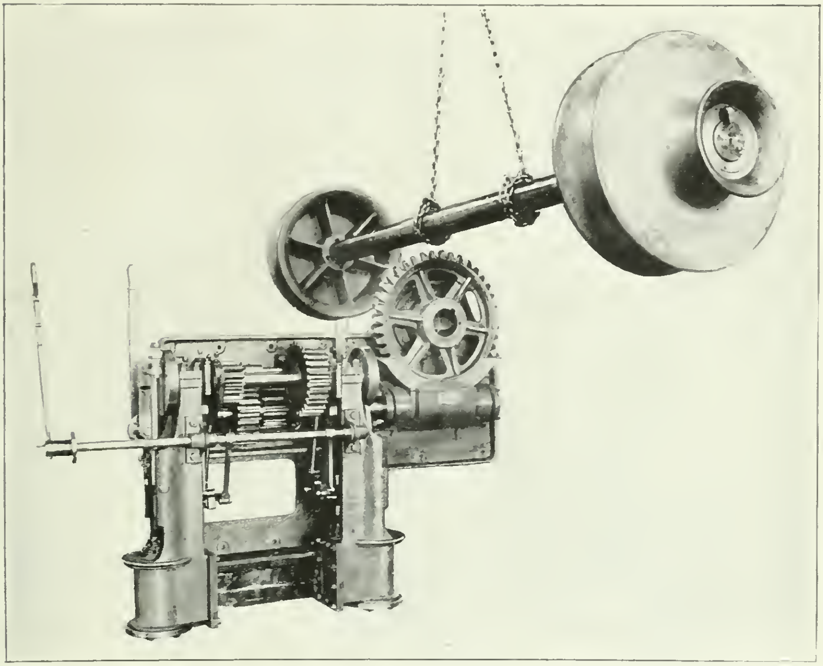
Installed on U. S. torpedo boat Stringham. Weight, 1 593 lbs. Stows 60 fathoms ⅞-inch wire cable on each drum. Lifted 2,250 lbs. with 60 lbs. steam. Made by Hyde Windlass Co.

ant Engineer W. W. White, of the United States navy, has thoroughly developed the lack of economy of the small steam auxiliaries. Mr. White made an extensive series of tests of the steam consumption of all the various engines of the Minneapolis and he discovered a condition of affairs that was startling. There is no use in giving all his results here. It is sufficient to say that the average steam consumption per i. h. p. per hour of the auxiliary machinery of the Minneapolis was found to be 119 pounds. This result was obtained with machinery operating under the average service conditions, with speeds and powers varying at different times. The consumption of the better class of the auxiliary steam engines, and of those which were worked frequently to their full capacity, was found to be approximately 52 to 75 pounds per hour, the consumption of some of the pumps being considerably less than 100 pounds per hour. For some of the slow-moving, direct-acting steam pumps, operated, as they not infrequently are, with a choked exhaust to ensure smooth



STEAM-DRIVEN TORPEDO-BOAT WINDLASS FOR ⅜-INCH WIRE CABLE.

Installed on United States torpedo boats Foote, Rodgers, and Winslow class. Made by Hyde Windlass Co.

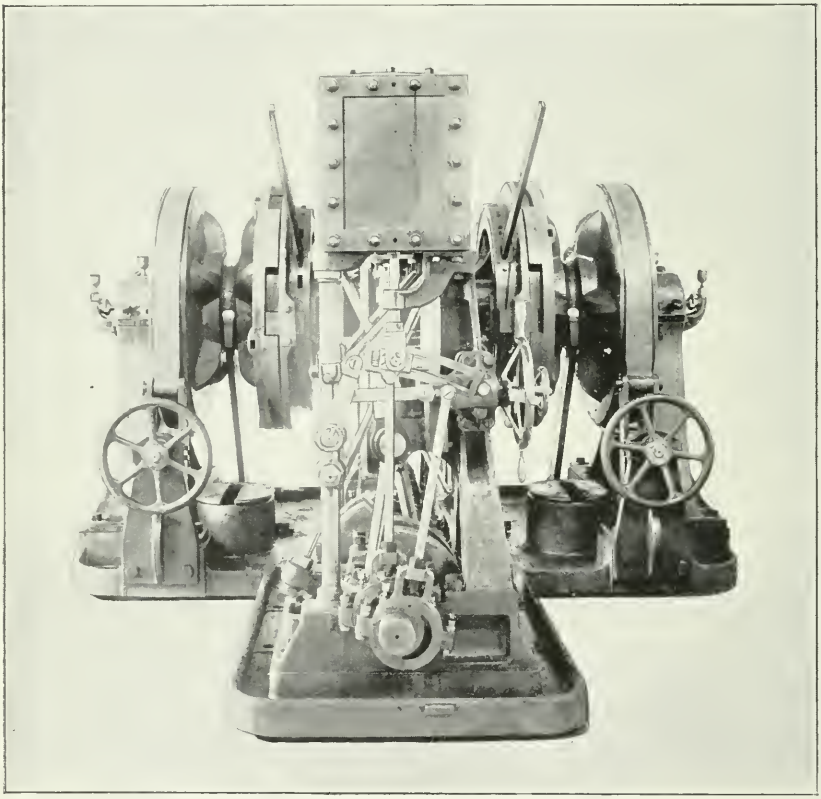


AUXILIARY STEAM WINCHES WITH 8 x 8 ENGINES.
Installed on United States battle-ships Kearsarge and Kentucky. Made by American Ship Windlass Co.

operation, the steam consumption was found to be more than 300 pounds. With ordinary auxiliaries in operation, with the ship cruising at about 10-knots speed and with the main engines developing about one-twelfth their maximum power, the steam consumption of the auxiliary machinery was found to be about 23 per cent. of the total amount of steam used.

The publication of the results of the experiments made on the Minneapolis was, perhaps as much as anything else, the cause of the great variety of investigation and progress on the subject of auxiliary machinery that has taken place within the last two years. Trials of the British cruiser Arrogant showed a steam consumption by the auxiliary engines, when the ship was working at low powers, of about 35 per cent. of the total steam consumption. Similar bad results were obtained on the Powerful. Recent experiments on some English ships indicated that the steam consumption of the auxiliary machinery was about 22 per cent. of the total when the engines were working at one-fifth power, the relative auxiliary consumption decreasing as the power increased, to about 10.4 per cent. of the total at three-fourths power. These results were obtained on the Argonaut. Somewhat better results are stated to have been obtained on the Vindictive.

The United States Navy Department, instead of merely securing the best auxiliary machinery in the market, has made demands for unusual economy-performance of the steam auxiliaries. The manufacturers of small engines, and particularly the manufacturers of steam pumps, have devoted their attentions within the last few years to the production of economical auxiliary machinery. Recent tests made by officers of the United States navy show that with compound pumps, now so widely used, the steam consumption has been cut down to a point considerably below 80 pounds



STEAM WINDLASS FOR 2½ INCH CHAINS.

Double engines, marine type, 15 x 14. The friction bands are strong enough to ride by. Weight, including chain stoppers, about 30,000 lbs. Installed on United States battle-ships Kearsarge and Kentucky. Made by American Ship Windlass Co.

per effective horse power per hour. Manufacturers of the best types of small steam engines for driving centrifugal pumps, fans, etc., have considerably improved the economy of these engines, cutting down the steam consumption to about 50 or 60 pounds per i. h. p. per hour. The evaporating plants of ships are now often arranged to work as double- and triple-effect plants. The only objection to this system appears to be the increased space required. This system has already been fully discussed in THE ENGINEERING MAGAZINE, and it is sufficient to state that, with the new methods of operation, the steam consumption of the evaporating plants has been reduced at least 30 per cent. In short, we may take it that within the last five years the average steam consumption of such auxiliary engines as are now installed on men-of-war has been reduced from 120 pounds per i. h. p. per hour to 65 or 70 pounds per i. h .p. per hour.

All of the foregoing investigation, or at least nearly all of it, was caused by a desire to increase the efficiency of the auxiliary machinery of ships as steam users. Many general changes have been made in design with the same end in view. The exhaust from the auxiliary machinery has not infrequently been arranged to run into a feed heater where the latent heat is entirely abstracted from the exhaust steam and used in raising the temperature of the feed water to about 210° F. This practice is to-day almost universal. It is frequently, and indeed generally, found that the amount of steam used by the auxiliary machinery, when the main engines are operated at as much as one-fifth full power, is not in excess of that required to heat all the feed water to the figure above quoted. Consideration should be given, however, to the fact that, in many cases, the power developed by the main engines is considerably less than one-fifth their maximum power, and in these instances it is not infrequently the case that the feed water will not condense all the exhaust steam from the auxiliary system at atmospheric pressure. Connections between the auxiliary exhaust pipe and a low-pressure evaporating plant (the second effect of a double-effect evaporator) have been made in many ships, the object being to care for any surplus exhaust steam that could not be condensed in the feed heater.

Probably the introduction of the auxiliary feed heater is the greatest step towards economy that has been made of late years in marine engineering. As at present arranged, steam is taken from the boiler to operate the auxiliaries and the exhaust is condensed in heating the feed water, the condensed exhaust steam being generally returned to the boiler by the feed pumps. This involves the conversion of the auxiliary machinery into theoretically-perfect engines. Their efficiency (radiation, friction, etc., not being considered for the moment), is practically unity. Every thermal unit abstracted from the boiler is converted either into useful work done in the auxiliary machinery or into useful work done in heating the feed water. The economy due to the use of the auxiliary feed heater is something like 8.9 per cent., as can readily be seen from the following:

Without the auxiliary heater the temperature of feed was ordinarily about 100° F. to 120° F.—say, as an average, 110° F. A series of tests at sea on the Minneapolis showed the average temperature of the feed water on that ship to be about 85° F. With the auxiliary feed heater in use, the temperature of the feed has been raised to 200° F. or 220° F. Some experiments show a temperature of feed as high as 234° F. It is not generally considered advisable, however, to pass 212° F., the temperature of evaporation of water at atmospheric pressure. Generally speaking, it may be said that the temperature of the feed water with the auxiliary feed heater in use, as now generally provided for in all marine designs, will be about 210° F. For the production of saturated steam at a pressure of 200 pounds from a temperature of 110°, 1,120 B. T. U.'s are required. If the temperature of the feed be increased to 210° the number of B. T. U.'s required for the generation of one pound of saturated steam at a pressure of 200 pounds is reduced to 1,020. The ratio between these two figures, 1,020 and 1,120—91.1 : 100—represents the ratio between the coal burned with and without the auxiliary feed heater in use. This is almost absolutely true, inasmuch as the steam consumption of the auxiliary engines is not appreciably increased by the raising of the back pressure from 4 pounds to 15 pounds absolute.

The foregoing is probably the best solution that steam engineers have given this problem. Other suggestions have been made, however, which are decidedly good as far as they go. For example, in many cases provision has been made for leading the exhaust from the auxiliary machinery into the low-pressure receivers of the triple-expansion engines generally fitted in naval vessels. In one case (the Olympia) an experiment with this adjunct in use showed a saving in coal burned of about 4 per cent. In other cases the result has not been so satisfactory, on account of failure efficiently to remove the entrained water from the exhaust steam of the auxiliary machinery. Some English engineers have proposed to work the auxiliaries in series, operating some of them by the exhaust from others, and finally turning the exhaust of the second set of auxiliaries into the evaporators. It practically converts the auxiliary machinery into triple-expansion engines. Other engineers, noting the gross waste due to the use of steam at 250-pounds pressure in the auxiliaries, have proposed to fit a reducing valve on the auxiliary steam pipe operating all the small engines with a pressure not to exceed 160 pounds.

With the progress that has thus far been made in the design of auxiliary machinery, the average steam consumption of the auxiliaries has been brought below 70 pounds per i. h. p. per hour, as has already been said. Recent tests show that the steam consumption of the increased large number of auxiliaries fitted in naval vessels is from 10 to 20 per cent. of the total steam consumption, according to the speed of the ship. With a feed-water heater installed, it is properly maintained that, as long as the auxiliaries use no more steam than can be directly condensed in this heater, it makes no difference how much steam the auxiliaries use, inasmuch as every heat unit is usefully abstracted from every pound of steam passing through the auxiliary system. It is further asserted that any excess of steam used by the auxiliary system, above that required in the feed-water heater, can be very economically utilized in the evaporating plant. This use of the auxiliary exhaust steam offers disadvantages, on account of the complexity of the piping, and particularly on account of the necessity of maintaining two pressures in the auxiliary exhaust system. It has been found impossible to obtain satisfactory results from the evaporating plant if the steam pressure is below 25 pounds. The use of the auxiliary exhaust in the evaporating plant, therefore, necessitates fitting delicate differential reducing valves in the exhaust system. These difficulties have been satisfactorily overcome in several English men-of-war, with a most satisfactory resulting increase in the economy, amounting in one case to .15 of a pound of coal per hour for each horse power of the main engines.

The theoretical proportion of the total amount of steam used, condensible in a feed-water heater which shall raise the temperature of the feed water 100°, may be shown to be something less than 10 per cent. When the losses due to radiation are taken into account, as well as the loss due to condensation of steam in the auxiliary engines and steam piping, it is found that as much as 12 per cent. of the total steam consumption can, after passing through the auxiliary system, be condensed in an auxiliary feed heater. Of course, where the initial temperature of the feed water is very low, this proportion can be increased; but, as a general thing, it may be stated that the amount of steam that can be allowed to pass through the auxiliary system must not exceed 12 per cent. if it is all to be condensed in a feed heater which shall not raise the temperature of the feed water above 212°. Tests have shown that the amount of steam required by the evaporating plant of a ship varies from 1 per cent. to 8 per cent. of the total steam consumption. It averages about 3½ per cent. of the total steam consumption when the vessel is cruising at reduced speed. With the evaporators now generally provided for in naval design, it is found to require about 40 per cent. more steam in the evaporating plant for the same output of the exhaust steam from the auxiliaries is used instead of live steam from the boilers. Steam from the auxiliary system can, therefore, be used advantageously in the evaporating plant up to about 5 per cent. of the total steam consumption. Neglecting the possibilities of a connection between the auxiliary exhaust system and the receiver of the main engine, we have, as the maximum amount of steam which should be used in the auxiliary system, about 17 per cent. of the total, 12 per cent. being accounted for in the feed heater and 5 per cent. in the evaporating plant. If the steam consumption of the auxiliaries exceeds this amount it is a direct loss. If, on the contrary, it is less than this amount, unless the saving be accompanied by a reduction in the condensation throughout the auxiliary system, there will be practically no gain.

As has already been said, the steam consumption of auxiliary machinery, as at present fitted on naval vessels of the latest type, rises to about 20 per cent. of the total at the lowest speeds. For the speeds and powers prevailing in time of war the figures should probably be taken at somewhat lower than 20 per cent.—say about 18 per cent. The designers of steam auxiliaries have, therefore, brought the steam consumption sufficiently low to reduce the waste under the most trying conditions to 3 per cent. and this waste in time of war will probably never exceed 1 per cent. The complex fittings required to enable the turning of the auxiliary exhaust into the evaporating plant, as well as the increased amount of steam required to operate the evaporators under these conditions, would make it advantageous to reduce the auxiliary consumption of steam to such a figure as would allow of its all being condensed in the auxiliary feed heater. There is room, therefore, for considerable further improvement in the design of auxiliary machinery. In the next number of The Engineering Magazine I shall consider the promise afforded by the adaptation of electric operation to marine auxiliaries, and the limitations which seem to affect the adaptation, on shipboard, of the central-station practice which has given results so good on shore.

EDITORIAL COMMENT

THE work of the International Association for Testing Materials, which forms the subject of a review elsewhere in these pages, was recently set forth in THE ENGINEERING MAGAZINE in leading articles by Mr. W. R. Webster and Mr. Gus. Henning. It is gratifying to see that both the increase in the membership of the Association and the increase of recognition of its work by the industrial press bear witness to the growing appreciation of its value to the engineering world. The radius of engineering trade is continually lengthening; the farther it extends, the more emphatic is the need for a basis of absolute understanding between bidder and receiver of bids—between buyer and seller. "The foundation of knowledge is laid in definitions," and the association is working toward an international agreement upon the definitions which are essential to a mutual understanding between purchaser and maker. The mere introduction of physical tests was an enormous advance step toward security. Their unification as to method is the necessary complement. When the builder of an engineering structure, or the purveyor of engineering materials, knows exactly how the consignee's requirements are to be interpreted; when the purchaser knows exactly how the furnisher's guarantee is to be construed—an era of mutual confidence will be established which will be enormously conducive to industrial security and engineering expansion.

WHEN Solomon was building the temple, he called upon Hiram of Tyre for the hewing and fashioning of cedar wood, for the cutting and moving of "hewed stones to lay the foundations of the house," and for cast work and wrought work in brass. In other words, Hiram was directing a general engineering business, and, under the conditions of the time, it was doubtless a wise policy.

In the three thousand years since elapsed, the wood, stone, and metal trades have become fairly well differentiated; but many British engineering works are to-day undertaking a business almost as diversified as that of the old Sidonian. But the signs of change are apparent everywhere, and in this issue three great exponents of advanced thought and practice—Sir Benjamin Browne, Mr. J. Slater Lewis, and Mr. Henry Roland—begin, each from a different viewpoint, three strong expositions of the new order of specialisation and standardisation.

This movement, in which the United States is far more advanced than the Old World, promises, indeed, to be one of the greatest of the century—and that is saying a good deal in a century which saw the birth of steam and electricity and the general introduction of machinery. It is greatest because it provides the method by which to use most effectively and economically the new forces and their media of application. The world is increasingly intolerant of waste, either of material or energy. Diffusion of study and attention, duplication of plan and plant, the compromise of the ability to do something well for the ability to do many things indifferently—all these are waste of the most flagrant and irretrievable kind—waste of productive power which, unused to its full, is lost forever. Society, as it grows more complex, tends increasingly to larger community of interest and minuter differentiation of individual function. The order of evolution is the same for the mechanical industries, and the gradual dissolving of national limits in industrial competition is one of the most potent agencies in working out the process.

* * *

Specialisation has three great beneficial results—it quickens production, cheapens production, and raises the quality of the product. Of these the third is, of course, essentially the greatest. The world is learning daily to be more and more critical of engineering manufactures, and only the best can long survive. But temporarily it seems as if quickened production were almost the most important end for which to strive. Many of the recent purchases of American locomotives for British and European installations have been determined by possibility of quick delivery. In the lately-reported case of the ordering of Baldwin locomotives for the Saxon railways, the contract is said to have been given to the American firm at a slightly higher figure than that asked by home builders, solely because the engines could be supplied more quickly from Philadelphia than they could from any of the German works.

There is no possibility that return will be made to the leisurely methods of working which are so closely associated with the policy of generalised engineering manufacture. The new countries, which are being suddenly awakened and hurried forward in at least the material phase of civilisation—the precipitated demand of nations more numerous than the whole white race, and with the accumulated needs of centuries of stagnation to be made good—these are going to tax the productive capacity of the whole industrial world, and every method and every institution which interferes with the realisations of the ultimate possibility of output must be discarded, or will be swept away. Intensified production is the motto of the times. Capital seems to appreciate the situation more clearly than labour. And the next great problem to solve relates to the care of the worker. It is foreshadowed in McAndrew's Hymn:

> * * * "What I ha' seen, since ocean-steam began,
> Leaves me no doot for the machine: but what about the man?"

As Mr. Orcutt put it, in concluding his papers in the August number of THE ENGINEERING MAGAZINE: "How to mitigate the incapacitating effects of routine work is one of the coming industrial problems." It may work itself out with as great a reversal of anticipatory fears as did the introduction of labour-saving machinery. But it is deserving of the most earnest thought of the best thinkers. Sir Benjamin Browne's third paper, in THE ENGINEERING MAGAZINE for December, will be devoted to this phase of the question.

REVIEW OF THE BRITISH PRESS

The Liverpool Motor Trials.

WHILE it appears to be generally conceded that France has made the greater progress in light motor vehicles, especially for personal and pleasure use, the tendency in England has rather been toward the design of less ornamental but probably more useful machines for carrying merchandise.

The recent trials of motor vehicles held at Liverpool under the auspices of the Liverpool Self-Propelled Traffic Association, of which accounts are given in both *Engineering* and *The Engineer,* furnish some interesting data as to the construction and performance of heavy motor vehicles for carrying goods.

The trials of last year demonstrated two facts which had material influence upon the competitions which have just been held. In the first place the poor quality of the roads showed the necessity for much stronger wheel construction than had been thought necessary, and in the second place the availability of steam motors for such work was clearly shown.

This year the only motors exhibited were steam engines, and with high-pressure boilers and air condensers ample power appeared to be attainable.

The chief object of the trials was to encourage the development of types of heavy motor wagons suitable for the trade and agricultural requirements in the neighbourhood of Liverpool, capable of economically taking the place of horse haulage and of competing with the existing railway rates in the transport of heavy loads of goods over distances of forty miles. The distances between the stations provided for the supply of water did not exceed twelve miles in any case, and the roads offered grades ranging from 1 in 22 to 1 in 9, with surfacing of various kinds.

But six vehicles appeared for the trials, and these are fully described in the journals referred to. As evidence of the experience of the previous year a few details may here be mentioned. The vehicle of the Steam Carriage and Wagon Company (Thorneycroft) was provided with wheels intended to overcome the weakness formerly developed. Instead of iron wheels driven by chain gearing, heavy wooden wheels are now used, but these are not driven directly from the hub, but by means of plate springs fixed to the axle and connecting with the wheel rims. This method not only avoids shock in starting, but also removes the twisting action on the spokes which occurs when the driving is applied at the hub. Two machines of this kind were exhibited, the boilers being of the Thorneycroft type, for use with oil fuel, and the compound engines being enclosed and connecting with the wheels by spiral spur gearing.

The other vehicles did not show such material differences from those exhibited last year, but that the re-design was an improvement is evident by the superior manner in which the Thorneycroft vehicle performed.

The trials demonstrated very clearly the practicability of such vehicles for regular service so far as manipulation and carrying capacity are concerned, while the crucial test of commercial economy can only be determined by prolonged usage. The hill-climbing tests showed that there was ample power in the machinery and that adhesion to the road bed was the essential matter, since the hills were climbed more successfully by the vehicles when loaded than when running empty.

The significance of these trials may not appear at once, but there can be little doubt that they and other such experiments are forerunners of the general application of mechanically propelled vehicles for general uses of all kinds. The whole subject of hauling on common roads is far behind the rest of modern industrial methods and now that energetic attention is being directed to the subject there is every reason to believe that there will be no relaxation until success has been mechanically and commercially attained. The question of road construction will have to receive the same attention that is now given to permanent way for railways, and under the open competition which exists in design and construction of vehicles there is every reason to expect rapid and practical advance.

Progress in Space Telegraphy.

It is generally understood that the vital feature in telegraphy across space without the use of conducting wires lies in the action of the coherer, and hence anything which adds to the sensitiveness or efficiency of this portion of the apparatus is of especial interest. In the apparatus as heretofore used it has been necessary to provide for the restoration of the particles in the tube of the coherer by tapping after each impulse, and this has led to a complication of the apparatus and has limited the speed of transmission to about ten words per minute on the Morse code.

A paper recently presented to the Royal Society by Professor Chunder Bose gives details of some interesting and important experiments made by him upon coherers of various metallic substances, which go to demonstrate that rapid and automatic decohering is entirely practicable. The paper is published in full in the *Electrician,* together with editorial comments expatiating on the importance of these investigations, and an abstract of both is here given.

The ultimate object of these researches was to determine, if possible, the correlation between the chemical associations of the materials used in coherers and that particular physical property, or group of properties, by virtue of which coherence takes place. For this purpose a systematic study of the properties of various metals and combinations was made, and while the result has not settled any definite or exact relation between composition and cohering action a number of important and valuable practical facts have been brought out.

The use of iron or steel in damp climates gives troubles from oxidising, and a consequent reduction in sensitiveness, and to overcome this difficulty experiments were made by coating steel spirals with deposits of various metals, and subsequently fine silver threads were employed instead of the steel spirals. The silver threads were coated with cobalt in an electrolytic bath, this surface being found very sensitive to electric radiation and not liable to such chemical changes as occur in the case of steel.

Dr. Chunder Bose describes in detail the apparatus by which he was enabled to make experiments with various metals under closely graduated degrees of pressure, and then proceeds to examine the behaviour of the different substances to be tested. He at once found differences under different conditions, the pressure and the e. m. f. of the current also exercising marked influence upon the electrical resistance. The especial fact of importance which appeared was that with some materials the action of the electric waves increased the resistance instead of decreasing it.

With the ordinary coherer it has been assumed that the passing of an electric wave caused the particles to unite, or cohere, thus diminishing the resistance and permitting the passage of the current to the receiving instrument. These experiments show that the action of the waves is to vary the resistance, but that with some materials, notably with the metals of the alkali group, the resistance is increased. When potassium was used, the first experiments appeared to show no response to radiation, the galvanometer needle remaining immovable, but, thinking that this might be due to response followed by immediate recovery, a telephone was substituted for the galvanometer, and the truth of the supposition was demonstrated.

This at once suggested the possibility of using potassium to make an automatic coherer, but it was found that this power of self-recovery ceased after twenty or thirty flashes, although it could then be restored by tapping. When the coherer is immersed in kerosene the power of self-recovery is not lost, and some construction of this sort may become of much practical value.

"Given a coherer that will always promptly de-cohere on the cessation of the Hertzian impulse, many achievements would be possible in wireless signaling which are now quite impracticable. Wireless telephony would be easily attained; though, by the way, the possessors of wireless telephones would have to be restricted to one happy couple within each area of influence. In bygone days steam engines were worked by the aid of little boys stationed at the valves. The lads worked perfunctorily; but the service was good enough for the engines, which were never expected to go beyond a very slow speed. Had automatic valves not been invented, high-speed engines would have been an impossibility. The coherer practice of to-day resembles the steam-engine practice of the days when the boys worked the valves. Wireless signals can only be sent with that painful slowness—say, ten words per minute on the Morse code—which is the limit of the performance of a coherer depending upon the attentions of a mechanical tapper. When the coherer has been invented that will automatically and promptly de-cohere, wireless signalling will make just that same advance upon its present condition that the steam engine made when automatic valves came into use. Dr. Bose's researches furnish one more step, and an important step towards that goal."

The Arrangement of Marine Boilers.

In view of the interest which has been shown in the subject of water-tube boilers, and of the conflicting experiences of various countries and vessels in connection with the steam-generating portion of naval equipment, the paper of Mr. F. T. Marshall before the Institution of Naval Architects upon the boiler arrangements of certain recent cruisers is especially timely. Although the paper refers particularly to the boiler arrangement of but a few vessels it is of especial value, since in these vessels are included, beside the ordinary cylindrical fire-tube boiler, both varieties of water-tube boiler, the large-tube system being represented by the Belleville boiler and the small-tube design by the Yarrow boiler.

The vessels especially under consideration are H. M. S. Andromeda, built at the dockyard at Pembroke, and the Portuguese cruiser Dom Carlos I., built at Elswick, and the Chinese cruisers Hai Tien and Hai Chi, also built by the Armstrong Company. To these have been added data about H. M. S. Heimes, and H. M. SS. Aeolus and Pallas, which are typical second and third-class cruisers with cylindrical boilers. Of these vessels the Andromeda and the Hermes are fitted with Belleville boilers, the Chinese boats and Aeolus and Pallas have cylindrical boilers, and the Dom Carlos I. Yarrow boilers.

The Belleville boiler, which is of especial interest at the present time, is an excellent example of the so-called "large-tube" variety; and when arranged, as in the case of the two vessels above named, with economisers, the performance, so far as fuel economy is concerned, is all that could be desired. The general construction of the Belleville boiler is sufficiently well-known to need no detailed account here, and in the case of the Andromeda the generator sections were composed of solid-drawn steel tubes, 4½ inches in diameter, galvanised externally, while the economiser elements were of tubes 2¾ inches in diameter.

The Yarrow boilers on the Dom Carlos I. differ in some minor respects from the usual construction. The tubes are of solid drawn steel, 1⅛ inch in diameter, except the two rows next the fire, which are 1⅜ inches in diameter, and are slightly curved in order to allow for the expansion due to the effect of the heat. Straight external downcomer tubes are fitted at each end, and a certain number of tubes are also baffled off from the fire to assist in maintaining the uniform direction of the circulation. In the Belleville boilers the feed is controlled by the Belleville automatic device, a float regulating the speed of the pumps, while in the Yarrow boilers the steam supply to the feed pumps is taken from a guarded pipe just above the water level, so that, if the water is high in the boiler it enters the pump cylinder and checks the feeding.

The boilers of the various vessels are tabulated in Mr. Marshall's paper in such a manner as to make a comparison possible, and the deductions which he draws may be taken as a very fair statement of the various types. Considering first space and weight, the horse-power developed per square foot of floor space under natural draft is practically the same for all three types. On the question of weight, however, the two water-tube types are substantially lighter than the cylindrical type, the Yarrow type being the lightest.

On the basis of maximum power the Yarrow type shows by far the greatest advantage, while the Belleville is not materially lighter in this respect than the cylindrical boiler, owing to the fact that it is not forced.

Taking into consideration the matter of forced draft, the Yarrow boiler can stand forcing to an air pressure of 2 inches for an indefinite period, the limit in this respect seeming to be rather the endurance of the men than of the boiler. The cylindrical boiler cannot stand forcing for a much longer period than four hours, after which period the power could hardly be maintained and the efficiency would fall off, although the speed obtained in this period might indeed be the salvation of the ship, a matter which ought not to be overlooked. Naturally the cylindrical boiler is at a great disadvantage in regard to the quick raising of steam, and in this important matter the water-tube boilers of either type show a marked superiority.

In the opinion of the author of the paper the greatest objection to the Belleville boiler lies in the enormous mass of mechanical detail, the great number of joints being especially undesirable. In this respect the Yarrow boiler has the advantage, but in both cases the use of a number of units complicates the piping and involves many extra fittings. The following conclusions are given as a result of the comparative study of the three types, each being considered merely as a representative of a class:

"The Belleville type is well adapted for maintaining high continuous sea speeds for long periods, and is very economical at high powers. It is comparatively light and well arranged for cleaning and overhaul. Steam can be raised quickly, and large variations in power made readily. It cannot, however, be forced, and has also the objection of great complication of detail and accessories, with consequent liability to derangement.

"The Yarrow type is hardly so well adapted for continuous steaming at relatively high powers, and is not so economical, except when fitted with the feed-heating arrangement recently devised by Mr. Yarrow. It can, however, be forced to almost any extent with safety, and much higher speeds obtained for considerable periods. Steam can be raised quickly, and large variations in power made readily. It is extremely light, and, being simple in detail, has small liability of derangement. Cleaning and overhaul are fairly easy, but the examination of the outside of the tubes is difficult.

"The cylindrical type is about equal to the Yarrow for continuous high-power steaming, though probably slightly less economical. At low powers, however, it is very economical. It can be moderately forced with safety, and is well adapted for ordinary cleaning and overhaul. All its arrangements are extremely simple and unlikely to become deranged. Sea water can be used in it with safety. It is, however, heavy; steam can only be raised very slowly, and large variations in power cannot be made quickly."

The Speed of Battle-ships.

THE importance which is generally attached at the present time to the question of speed in war-ships renders an editorial in the *Engineer* setting forth the other side of the case especially interesting. High speed cruisers are, of course, most valuable things, and the experience of the American fleet at the battle of Santiago showed the value of a battle-ship like the Oregon which can make a spurt in an emergency. The battle of Santiago, however, was not a battle at all in the accepted sense of the term; it was a chase, and that speed is the prime factor in a chase, either for the escaping fleet or for the pursuers no one can doubt. When, however, it comes to a pitched battle, so to speak, when success depends upon manœuvring ability almost as much as anything else, there is another side to the question.

It is indeed true that the fleet of greater speed can seldom, if ever, be forced into action by a fleet of inferior speed, but battle-ships were made to fight and not to run, and the work of chasing a flying enemy may be left to the fast cruisers, while the battle-ships do the fighting. When the enemy's fleet puts to sea it is supposed it is because it wants to fight, in which case guns and armour are of more value than speed. Even if the enemy puts on speed in order to join or combine with another fleet it would hardly be desirable then to catch it unless guns and armour were good enough to insure victory.

When the enemy's fleet is on the run it is almost certain that the inequality in speed will cause certain ships in the runaway fleet to drop behind, and these "lame ducks" will then be captured in detail, or the swifter runaways must turn and fight. The question of coal supply must also be considered, for the swifter vessel must have a proportionally smaller coal supply than the slower battle-ship, so that the superior speed may in some cases be the actual cause of destruction.

It is most important that a squadron should be homogeneous in the matter of speed if concerted action is to be possible. At the present time the only navy in the world that can put a homogeneous squadron into action is the British navy. A 15-knot squadron of homogeneous ships stands, when these are steaming together in station, to better a swifter fleet of various units, because these last will not be able to perform evolutions together at high speed.

As a matter of fact twelve knots is the highest speed at which fleet evolutions have yet been done, and that has only recently been accomplished. The next trials will be made at 14 knots, but such a speed in evolutions is only possible in a highly trained, regularly commissioned, and homogeneous fleet.

Taking all these questions into account it must be seen that while speed is a very important qualification for all naval vessels, it must not take first place for battle-ships, but must come after the questions of guns and armour. The original idea of the swift cruiser was that it should be able to destroy commerce, attack weaker ships, and run away from the heavier armed and protected battle-ship. Now, however, the idea seems to be that the battle-ship must add to its heavy guns and armour the speed of the lighter cruiser. It is impossible, and perhaps even undesirable to put two such contradictory qualities both in the first place. The heavier vessel cannot be the swifter, nor can the swift ship be so heavily armed; each has its place and function, and in the one speed comes first, in the other fighting power. The battle-ship should be a battle-ship, and the armoured cruiser an armoured cruiser.

If, with improvements in steam machinery greater power can be given to the battle-ship without undue increase in coal consumption, so much the better; but for the heavy fighting machine, a greater speed than can be used in the actual evolutions of battle is as likely to be a handicap as a service.

It is often easy for the general public to join in an agitation for something about which it is impossible that a correct judgment can immediately be formed, and this outcry for fast ships, regardless of the character of the work to be done, is a present instance. The speed of a vessel is but one of the factors of its usefulness and should be given its due share of consideration, but should not be allowed to dominate.

Apart from the question of nominal speed, the actual serviceable speed of a ship is a quantity which will bear consideration. Too many vessels have made high speeds on their trial trips which they have afterwards been unable to realise. The real serviceable speed of a vessel is one which should always be available at any time, and when a battleship can always respond to a call from the bridge for a speed of 16 knots, she is often better than the fast cruiser as to speed, when the vaunted 21 or 22 knots of a trial run is called for in vain.

Gun-power, armour, speed—these are the qualifications for a battle-ship, but they should be considered together, and the former should not be sacrificed to the latter.

Engineering Education.

In the profession of engineering, as indeed in all other professions, the question of the scope and value of the special education which must be obtained is always a live subject for discussion. At the present time this is especially the case since the competitive conditions which are obliged to be faced by industrial Great Britain demand that she shall not fall behind in this respect.

A recent editorial in *Engineering* discusses this question in a manner which demands thoughtful attention, taking as the immediate text the appointments for the science research scholarships for the present year.

After commenting upon the appointments in a general way the statement is emphatically made that the efficiency of the system devised by the commissioners depends upon the way in which it is carried out, and thus comes up the question of the value of examinations. It is beginning to be appreciated that the faculties which make a student a good passer of examinations are not those which are of the greatest value thereafter.

"A strongly receptive mind by no means denotes the creative faculty, and it is creators, not absorbers, of facts, for whom the industries of the country have need."

This whole subject received a thorough discussion at the meeting of the Institution of Mechanical Engineers at Plymouth in connection with Mr. Mayston's paper upon the course of study followed by the students at Keyham. Here it appeared that, while the main aim was that of preparing the students to pass examinations, yet at the same time every opportunity was given the student to develop whatever capacity there might be in him. It is doubtless true that scientific acquirements are not the only requisites necessary for success in life, and it is also admitted that the education and qualifications needed for a man worth £3,000 a year were not necessarily required to fill a situation of £3 a week.

These points may readily be admitted, but the real difficulty lies in the determination of the men who are to fill these different positions in life. Since it is impossible to forecast the future of the student from the beginning, it is desirable that a universal character should be given to the training until it has proceeded to such length that the weeding-out process may safely be begun. It is with this weeding-out process that the uncertainty appears. The mass must be sifted out by educational meshes of wider and wider texture until only the giants remain. The great problem is how to construct this net that the sifting process may be well done.

At the present time examination papers are about the only means available for this purpose, and there seems to be no better expedient for testing a man's capacity for gorging and disgorging facts. If the selection were left to the professors we should need a different class of professors from those now available, and indeed it is a question how any professor who had not himself been through the test of practical life could be of much use in this respect.

It is too often the case that when a man who has had a scientific education fails to profit by his opportunities the fault is laid at the door of the educational establishment and the system is condemned. In many such cases the man would have been a failure under any system, and the old so-called "practical" system, with its apprenticeship of hard knocks and blunders, turned out quite as many failures as do the modern institutions.

The real fact is that the education received at any institution can only be regarded as a preparation for the practical side which must come later, and should be regarded as only a preparation in any case. Practice is continually changing, but fundamental principles can never change, and that education best fits a man for success in life which grounds him thoroughly in those principles which are at the bottom of all applied science and art, while at the same time it impresses upon him that what he is learning is only a foundation upon which he must erect the superstructure himself. Too often the successful cramming which has enabled a student to pass an examination with flying colours has really unfitted him altogether for subsequent success in life, not only because it has failed to teach him the things which he must know in order to attain success, but because it frequently leads him to believe that the mere passing of the examination in itself constitutes success. Examinations are all very well in their way, but the student himself should be his own strictest examiner, and his examination paper should not be that set before him by his teachers, but that which his own ambitions for the future may set before him.

REVIEW OF THE CONTINENTAL PRESS

Steel Castings for Structural Work.

THE new Alexandre III. Bridge across the Seine at Paris has already been described in the pages of this Magazine, and other accounts have also been reviewed in these columns, but the work contains so much that is of professional and technical interest that some of the details of its construction have more than an immediate application. For this reason some review of a portion of the official description of the work prepared by the engineers MM. Résal and Alby for the *Annales des Ponts et Chaussées* is here given, especial attention being directed to the steel voussoirs and the methods of casting them.

While the bridge is wholly metallic yet it is designed upon principles almost identical with those involved in the design of a masonry arch. There are a number of separate arch ribs, but each consists of blocks or voussoirs, performing similar function to dressed stone voussoirs in a masonry structure, and while these are bolted together there is intended to be little or no tension upon the bolted joints, the curve being such that there is no bending moment, the entire arch being in compression. Since the arch is hinged at the crown and at the springings, the curve of pressure can be very definitely determined for various loadings, and upon the mean curve of pressure the entire shape of the arch is based, a segment of a circle being used for the intrados and a curve of several centres for the extrados. From the original drawings a set of working drawings were made, giving the shapes of the voussoir by rectangle co-ordinates, thus avoiding the necessity of sweeping the great curves full size in the workshop, and these details were used for the actual construction.

Owing to the limited time available for the completion of the bridge, in view of the approach of the exposition, the work was entrusted to five of the most prominent establishments in France, *i. e.,* the works at Châtillon, Saint-Chamond, Creusot, Saint-Etienne, and Firminy, each of these establishments being given the privilege of making the parts according to its own methods, keeping in strict conformity with the drawings and specifications.

The account shows in a very interesting manner the different methods employed by the various firms in executing and assembling the work. In some cases platforms of concrete or timber, covered with sheet-iron, were constructed, upon which the curves of the arch were laid out from the co-ordinates given on the drawings, while in others carefully levelled blocks were set at points corresponding to the joints between the voussoirs and used for the verification and assembling of the parts. At Saint-Etienne, where the character of the soil is such as to make solid foundations difficult, the curves were traced twice, in order to correct for variations which appeared during the successive assembling of the arches.

The various methods of moulding and casting the steel pieces form a most interesting study, as showing the different practice of these noted works. The general scheme of moulding was the same in all cases, a three-part flask being used, the middle portion containing the pattern of the ribbed plate forming the voussoir, and the upper and lower parts holding the cores. In all cases the castings were poured lying on the side, the flask being blocked up at an angle, but the gating and venting was not the same in all cases, and the angles varied greatly. A sheet of diagrams showing the details of moulding and pouring in the various cases is given with the original paper and forms an interesting study in foundry methods.

The different establishments proceeded differently in regard to the cooling and annealing. In most cases the moulds were allowed to remain untouched for at least 24 hours, after which the castings were removed and annealed, but at Firminy several days were allowed to elapse before the moulds were touched. In some cases the castings were partially uncovered, in order to allow the cooling to take place in such a manner as to prevent warping, but this did not seem to be considered necessary in all cases.

The practice in regard to the annealing is also of interest, as it varied both in duration and temperature in the various works. At the Chatillon works the casting was raised to a temperature of 950° to 1,000° C., which required about 30 hours; it was maintained at this heat for about 6 hours and then gradually allowed to cool, this latter operation taking 72 hours, making a total of 108 hours. At Saint-Etienne the operation was about the same except that the cooling was accomplished in 30 to 36 hours, the whole operation being completed in from 72 to 80 hours. The operation at Firminy was peculiar. A gradual heating to 900° was given, lasting from 35 to 40 hours, and the furnace doors were then opened and the temperature allowed to fall suddenly to 600°; the doors were then tightly closed and the casting allowed to cool during 45 hours.

The practice at Creusot was to place the casting in an oven as soon as practicable after pouring, where it was allowed to cool slowly. This attained a portion of the result intended to be accomplished by the annealing, and rendered the subsequent operation much shorter. The cooled casting was reheated to 1,000° C. and kept there for two hours and then cooled in 12 to 14 hours.

Since the tests showed the various products to come up to the standard required by the inspecting engineers it is evident that the various methods of treatment were based on successful experience with the metal employed in each case. The average tensile strength was 75,000 pounds per square inch, with an elastic limit of 40,000 pounds and an elongation of about 18 per cent.

The Resistance of the Air.

One of the elements of much importance in connection with computations for rapidly moving vehicles, whether through the air or on the surface of the earth, is that of the resistance offered by the atmosphere at various speeds. In order to stimulate investigation in this line of work, the *Société d'Encouragement* offered a prize for the best experimental study of the subject of the resistance of the air to moving bodies. A report upon this matter has recently been made by M. Barbet, for the committee on mechanic arts of the society, and the two papers which merited awards are now published, together with the original report, in the *Bulletin* of the society.

A number of papers were presented in response to the offer, but among these only the communications of M. l'abbé Le Dantec and of M. Canovetti were considered worthy of awards. These two papers are, without doubt, valuable contributions to the meagre stock of knowledge of the subject. That of M. Le Dantec is a record and discussion of experiments upon the vertical fall of planes under known conditions, the experiments having been made with very ingenious apparatus in the chapel of the Conservatoire des Arts et Métiers. The paper of M. Canovetti is a discussion of experiments made with bodies of various shapes and surfaces suspended from a trolley running on a long stretch of inclined wire, forming a sloping catenary of known shape and descent.

The apparatus used by M. Le Dantec was simple in conception and principle. A surface of given area, in this case one square metre, was arranged so as to fall vertically, being guided by a tightly stretched vertical wire. At the commencement of the fall there is an accelerated movement. The resistance of the air increases with the velocity of the fall and retards the movement and when the atmospheric resistance becomes equal to the weight of the falling body, the acceleration ceases and the motion becomes uniform. In the detailed record of the experiments a full description is given of the ingenious and accurate recording apparatus by which the exact moments of starting and stopping were electrically recorded on moving bands of paper, and the elimination of personal errors thus accomplished added much to the reliability of the results.

For a full account of these very interesting studies the reader must consult the original paper, but the final results may be given here. In the first place a square surface of one metre area, plane on both sides, moving at a velocity of one metre per second, encounters an atmospheric resistance of 81 grammes. Secondly, plane surfaces of the same area, but of various shapes, experience different resistances, and M. Le Dantec has discovered that the resistance of the air to surfaces of different shapes is proportional to the lengths of their various perimeters. Thirdly, within the limits of his experiments, M. Le Dantec has verified the law that the resistance of the atmosphere is proportional to the square of the velocity. In the experiments it was evident that eddies and currents in the air made very material differences in the results and that tests, to be comparable, must be made in still air.

The experiments of M. Canovetti were intended to be an improvement upon former ones made with carriages descending inclined planes. In the earlier experiments of this kind the frictional resistance of the carriage formed an important source of error, and the limited length of the planes permitted only small velocities to be studied. The apparatus of M. Canovetti enabled the frictional resistance to be much reduced, while the horizontal distance between the ends of the wire was 280 meters with a fall of 71.2 meters, a gradient of about 25 per cent.

The principal sources of error in these experiments lay in the fact that the varying slope of the catenary affected the velocity, and in the manner of determining the velocity by the use of an ordinary stop watch in the hands of individual observers. Nevertheless, the experiments gave interesting and valuable comparative results for bodies of various shapes tested under approximately the same conditions, and for this reason the paper was considered worthy of award.

The results in general agree very well with those of M. Le Dantec, the resistance of a plane of one metre area at a velocity of one metre per second being 80 grammes for a circle and 90 grammes for a rectangle. A right cone of an altitude of 1.5 times the base-diameter gave a resistance of 60 grammes, while a hemisphere with convex side forward showed only 22.5 grammes. When the hemisphere had formed upon its flat surface a cone of an altitude double the diameter of the base, the air resistance was reduced to 15 grammes, or only one-fifth that of a circular plane disk of the same diameter.

These tests show very conclusively the marked influence which the form of the moving body has upon the wind resistance, and may render material assistance in the design of machines for aerial navigation.

It is to be hoped that these trials are but the beginning of more extended experiments upon a larger scale and under varied conditions, in order that the very important subject of wind pressure upon engineering structures may be elucidated.

Petroleum Motors.

The high economy which may be obtained by the complete combustion of liquid fuel in an internal-combustion motor is now generally conceded, and as a result there have been numerous attempts to design motors which shall prove acceptable for general use. The Diesel motor has been fully noticed in these columns at various times, and now we have the Dopp motor, which was discussed at a recent meeting of the *Verein deutscher Maschinen-Ingenieure,* the account being published in *Glaser's Annalen.*

Dopp maintains that the high compression advocated and used by Diesel is not necessary to the attainment of superior thermal economy, and claims that equally good results can be secured by the use of vapourised petroleum, drawn into the cylinder with the proper proportion of air, and burned under practically the same conditions as obtain when gas is used in a well designed gas engine.

It seems to be generally admitted that the main element in the economy of a petroleum motor lies in the complete combustion of the fuel. While this is secured by providing a compressed atmosphere, it does not appear that it is necessary to use a compression materially greater than is now employed in the gas engine. The Dopp motor does not differ in general construction from an ordinary gas engine, except that the petroleum fuel is gasified by the heat of a lamp before it is drawn into the cylinder, and the excellent economy which appears in the regular service is claimed to be due only to the completeness of the combustion, attained by a thorough mixture of the fuel with the proper quantity of air.

Herr Dopp gives figures from a number of his motors in daily use which show a consumption of 0.197 to 0.240 kilogrammes of petroleum per horse-power-hour, the lower result being obtained with a 10 h. p. motor after it had been in practical service for more than 11 months. This result is better than was attained by the Diesel motor of 20 h. p. tested by Professor Schroter, although under less favourable conditions.

Herr Dopp maintains, as has been claimed by others, that the Diesel motor by no means realises in practice the theory enunciated by its designer, and shows that some of the fundamental points which, according to the theory are essential to the highest economy, are distinctly controverted in the working of the motor. From this he deduces that the high economy of the Diesel motor shows that the theory is not sustained.

An important feature of the motors constructed by Herr Dopp lies in the fact that they can be constructed and operated in a satisfactory manner for small powers, good results being obtained with motors of 2 to 5 h. p., while the construction of the Diesel motor is such that it does not appear advisable to make them for less than 20 h. p.

Regardless of the theoretical questions at issue, there seems to be little doubt that very simple, efficient, and convenient petroleum motors can be made upon the same general design as that already in public use for gas, and that care in design and in the correct proportion of air to fuel supply can, with a moderate degree of compression, insure such a complete combustion as to leave little or no trace of soot either in the cylinder or in the exhaust gases. Under such circumstances there can be little doubt that the petroleum motor has a most useful future before it, especially for small powers.

Masonry Chimney Construction.

Notwithstanding the attention which has been directed of late to the subject of mechanical draught for boilers and furnaces, there exists a strong prepossession among many engineers for the use of chimneys, and the masonry chimney still holds its pre-eminent position as a means of procuring a draught of air for the combustion of fuel.

The subject of chimney proportion has been frequently discussed, and various formulas, mostly based on the treatment of Rankine, have been enunciated, but it is an undoubted fact that empirical methods are for the most part used by those engaged in actual chimney construction.

In recent issues of the *Zeitschrift des Vereines deutscher Ingenieure,* the matter is treated from a theoretical and practical standpoint by Professor G. Lang, while in the *Mittheilungen aus den Königlichen technischen Versuchsanstalten* is given a report by Herr Max Gary of the tests of chimney masonry, made under the auspices of the Royal Testing Bureau, these papers together forming the latest contributions to the subject of chimney construction.

Beginning with the conditions of temperature, atmospheric pressure, and the expansion of gases by heat, Professor Lang deduces a simple formula for the computation of chimney height, the application of which he illustrates by several examples. This formula contains coefficients for chimneys of various sections, and enables a height to be deduced which will give any required velocity of gases for a given rate of combustion.

Passing on the details of chimney construction, Professor Lang discusses in succession the questions of materials, foundations, and stability, and gives some very complete investigations of the stresses in different portions of the structure under various conditions. The subject of the action of wind pressure is considered, and a brief table is given of constants to be used in his formulas for chimneys of different shapes, with the idea of rendering the discussion of immediate practical use. In fact the whole study of the subject by Professor Lang is intended to serve as a standard for practice of the German boiler-inspection office, and had its origin in the instructions of the Prussian Minister of Commerce and Industry.

The paper by Herr Gary is of an altogether different nature, but is none the less practical on that account. The Royal Technical Testing Laboratory at Charlottenburg, under the direction of Professor Martens, has been making for some time a series of actual tests of brickwork and other masonry under conditions approaching as nearly as possible those which obtain in chimney construction, and it is upon these tests that Herr Gary has reported.

The tests were instituted to examine into the following conditions:

1. Resistance of the single pieces to pressure, and to the action of weather, water, and acid vapours.

2. Resistance of mortar joints in general.

3. Resistance of mortar when the force acts at right angles to the construction, as in the case of wind-pressure.

4. Resistance of the vertical joints to circumferential pressure.

The whole elaborate plan of operations is detailed at length in the report, and to it the reader must be referred for the particulars, but some of the results will be of interest. The mean of a number of crushing tests upon brick alone was 671 kilogrammes per square centimetre, or about 613 tons per square foot. The compressive resistance for mortar joints from 1 to 5 centimetres thick, and 28 days old, ranged from 230 down to 54 kilogrammes per square centimetre, the higher values being for the thinner joints; and the general mean of 300 tests was 131.7 kilogrammes per square centimetre, or about 120 tons per square foot. Tensile tests of mortar joints showed figures ranging from 0.8 to 3.9 kilogrammes per square centimetre, or from 10 to 55 pounds per square inch, the mortar in the highest case being 90 days old.

The transverse and longitudinal trials were practically shearing tests, and gave the resistance of the combined brick and mortar, the rupture taking place through the mass and breaking both portions of the section. For mortar 90 days old the resistance to horizontal shearing was about 14 kilogrammes per square centimetre or about 200 pounds per square inch, while against vertical shearing it was about 9 kilogrammes, or about 130 pounds per square inch. Crushing tests made of brickwork masonry 9 months old gave an ultimate crushing resistance of 239 kilogrammes per square centimetre, or 218 tons per square foot, figures which may be of service in other connections than that of chimney construction.

Pulverised Fuel.

THE attention which is now being directed toward the prevention of smoke in connection with the generation of power by the combustion of coal has awakened renewed interest in the possibilities of pulverised fuel. An exhaustive review of the past and present practice in this branch of engineering appears in a series of articles in the *Schweizerische Bauzeitung,* and in view of the schemes which have recently been discussed, this review is of present value.

Pulverised fuel has been the subject of experiment since 1831, when Henschel, at Cassel, charged air with coal dust and used it for firing brick-kilns, and for welding and other smithy operations. Nearly 30 years later Pütsch attempted to use coal-dust firing for glass furnaces in England, and in the 70's Crampton made a number of applications of the principle to metallurgical operations.

In America the experiments of McAuley about 1881, and Hathaway in 1886, are well known, and at the present time the experiences of Wegener and others in Germany and elsewhere are attracting considerable attention.

Three fundamental principles are laid down for the successful use of pulverised coal as fuel. (1) The combustion chamber must be maintained at a high temperature; (2) the powdered fuel must be delivered into the midst of the entering air current, and the intimate mixture of air and fuel delivered into the combustion chamber in an uninterrupted stream; (3) the particles of coal must be maintained suspended in the air until they are fully consumed.

This last condition is very important, since if the particles fall out of the air current to the bottom of the combustion chamber mere coking will take place instead of a complete combustion.

A distinction must be made between powdered fuel and the ordinary coal dust which is found at every mine. The coal for use in air-blast firing without grates must be finely ground in a mill, so that it will pass a sieve of 900 meshes per square centimetre, and must be entirely free from any larger particles.

The first of the above conditions requires especial consideration in connection with internally-fired boilers, since the proximity of boiler surface to the burning dust will chill the furnace to an extent sufficient to make the combustion imperfect. In order to avoid this it is necessary to line the furnace with fire-brick, which by attaining a high temperature prevents the chilling of the flame and acts to equalise the temperature. There is no loss of heat by using such a lining, as the fire brick occupies only an intermediate position and the heat is ultimately transferred to the boiler surface.

The second condition, that of mixing the fuel with air and feeding the mixture into the combustion space, is the one which must be fulfilled by the construction of the apparatus, and the ingenuity of designers is mainly exerted in this direction.

The third condition is mainly dependent upon the fineness of pulverisation, and it is the cost of grinding the coal to the necessary degree of fineness which usually limits the commercial application of any process.

The Wegener furnace, about which much has been said of late, is an attempt to apply pulverised coal methods similar to those which have been used successfully with low-grade hydrocarbons, and with petroleum refuse, in Russia. In this apparatus the finely powdered coal is distributed into the incoming air by a revolving sieve, and the mixture is then driven into the combustion chamber by a steam jet. A firebrick lining permits the high temperature to be maintained, and as this soon becomes white hot, any slight inequality in the rate of firind does not permit a sudden chilling. The ash which exists in the coal is mostly fused to a liquid slag, which runs out a tap hole below, and it is found that there is no greater accumulation of dust in the boiler flues than occurs with ordinary firing.

A number of tests, conducted with especial regard to smoke-prevention, have been made in Germany, and the details of these do not show any extraordinary evaporative performance, from 8 to 9 pounds of water per pound of coal being the average result. The absence of smoke was practically attained in all cases, however, whenever proper precautions were taken to provide sufficient fire-clay surface in the combustion chamber to prevent chilling of the flame. This has been found difficult of accomplishment in the case of water-tube boilers, unless an entirely separate combustion furnace is constructed, since the presence of the tubes containing water checks the combustion to an extent sufficient to cause smoke to be produced.

The use of pulverised fuel can hardly be recommended on the score of economy, as the evaporation is little if any higher than that obtained by ordinary firing, while at the same time the cost of grinding the coal must be included. When, however, it is imperative that no smoke be produced, it appears that this is one of the various methods by which that desirable result may be attained.

The Siberian Railway.

THE progress of the Siberian railway has been noted in these columns from time to time, as the importance of the work demands, and we now note an excellent account in *Glaser's Annalen,* of the operation of that portion extending from Tcheliabinsk, the starting point in the Urals, to Irkutsk, near Lake Baikal. This completed part of the road is divided into two sections, the first extending from Tcheliabinsk to the Obi, a distance of 880 miles, and called the Western Railway of Siberia, the second, the Central Railway of Siberia, reaching from the Obi to Irkutsk, 1,136 miles more, or a total of 2,016 miles. There is also a spur extending from the station of Taiga to the city of Tomsk, a distance of 54 miles, which is now in operation.

The construction of the western portion of the road lay over a vast plateau, almost treeless, and the principal engineering features of interest are the bridges. Of these one of the most important is that over the Irtisch at Omsk. This consists of six truss spans of 350 feet each, and two shore spans of 75 feet. There are similar bridges over the Tobol and the Ischim, there being four spans in the first case and two in the second, all of 350 feet each. The bridge over the Obi has seven spans and a total length of 2,600 feet. All these bridges are of wrought iron and were built at the Wotkinski works in the Ural. Many details of the roadway construction, as well as the buildings and other fixtures are given in the article, and the work appears to be well done in standard Continental style.

The total cost of the Western Railway of Siberia was 46,124,698 rubles (about £4,960,000) while the estimated cost was 47,369,367 rubles (about £5,100,000) so that we have the unusual result of the cost of the actual work falling below the estimate.

REVIEW OF THE AMERICAN PRESS

The Sanitation of Havana.

It is generally recognized that an important portion of the work of the soldier in connection with military operations in new countries is that of executing such engineering work as may be necessary for the health of the occupants, and it is sometimes the case that such work is necessary in places which have previously been occupied by civilized people. An example of the latter case is found in the city of Havana, and a very interesting account of the conditions there found by the United States troops is given by Mr. E. Sherman Gould in *Engineering News*.

Taking the death rate as a measure of the healthfulness of a city it will be seen that Havana cannot be given a very favorable place, the rate being at present estimated at 30 per 1,000. This must, of course, be taken in connection with the natural disadvantages of the location. About 20 per cent. of the deaths are due to pulmonary diseases, these being attributed to the raw, damp weather of the winter season, together with the scanty clothing worn by the poorer classes. Yellow fever is endemic and paludic fevers and rheumatism prevail.

According to the population and the area given by Mr. Gould the density of population is high, reaching about 100 persons to the acre, and were it not for the fact that the general mild climate causes all houses to be thrown open to the air, a much higher death rate might be expected.

The objectionable features of Havana are the low-lying topography, the absence of anything like decent sewerage, the slight tides of the bay into which all drainage is delivered, and the need of good paving. Most of the houses are built directly upon the ground, without cellars and the soil beneath is often saturated with filth and moisture. Cesspools are common, and where connection with a sewer is made it is simply to relieve the liquid overflow, the unlined hole in the ground being cleaned only at long intervals. These cesspools are generally within the limits of the house itself, and must constitute an active source of disease.

The streets are irregularly paved, and generally in bad condition, and up to the time of the occupation by United States troops there had been no systematic street cleaning nor removal of garbage, this work being left for the sudden and violent showers which are of frequent occurrence. The one redeeming feature of the city, from a sanitary point of view, is the excellent and abundant water supply. This is brought from the Springs of Vento, a distance of seven or eight miles and distributed by nearly 90 miles of cast iron pipe. There is much waste of water, through defective plumbing and careless habits, and Havana might be cited as an excellent example to show that a high consumption of water does not necessarily add to the healthfulness of a city.

Since the military occuption, the care of the streets and sewers has been placed in the charge of the Engineer Department of the United States Army, and much has been done in the way of superficial improvement. The streets are regularly cleaned, and refuse carted away, loaded on scows, and dumped out at sea. Many of the sewers have been opened and cleaned and in all a great change for the better has been made in the appearance of the city.

Nothing has yet been done in the way of fundamental improvements, and it is hardly probable that any will be attempted during the military occupation, although it is more than probable it would be better so done than if left to the civil government which will probably have many other things to undertake.

The first step to be taken should be the establishment of a complete and efficient system of sewerage. This involves some satisfactory plan for the disposal of the sewage, as its discharge in a crude state into the almost stagnant bay is by all means to be avoided. It would probably be difficult to install a purification plant, owing to the absence of suitable disposal areas, while the alternation of festering heat and torrential rains would interfere with satisfactory operation. Mr. Gould suggests the tunneling of the hills and the delivery of the sewage into the littoral current beyond the Morro Castle, using both pumping and gravity for the maintenance of the discharge. This would doubtless be an expensive plan, but would make a final solution of the problem.

The repaving of the city should be done in connection with the sewerage works in order to avoid a prolonged tearing-up of the streets, and either asphalt or vitrified brick would be suitable, the latter probably the best in case of the settlement of the disturbed earth.

"Enough has been said to show that the problem of sanitation in Havana is by no means a simple one. It will be a gigantic enterprise to take in hand a city of some quarter of a million inhabitants, with narrow and crowded streets, and design and execute a complete and adequate system of sewers and street improvements with a minimum degree of interruption of traffic and inconvenience, and maximum economy. It is clearly a case where the highest special talent is required to prepare a carefully matured plan which shall best meet the peculiar conditions of the problem."

Heating by Exhaust Steam.

The use of exhaust steam for heating purposes is well-known in connection with factory power plants, but until recently it has not been considered as a part of the practice of central power stations. Recently, however, the electric-lighting company operating in the city of Providence has considered the feasibility of using the exhaust steam from its engines for the purpose of supplying heat to a surrounding district. Before proceeding with the execution of this plan a report was had from Professor J. E. Denton as to the probable cost at which exhaust steam could be supplied to the buildings, and from his report, as published in the *Engineering Record* we abstract some interesting information upon the subject.

At the present time the engines are operated condensing, and the proposed change would not only require the abandonment of the vacuum, but would also involve the operation of the engines against a back pressure of about six pounds above the atmosphere. This would make the absolute back pressure against which the engines must exhaust equal to about sixteen pounds.

The result of the calculations of Professor Denton is, that for the engines concerned, taking into account any saving due to dispensing with the air pump for operating the condenser, the change from condensing to non-condensing, with six pounds exhaust pressure above the atmosphere, would increase the consumption of fuel about 42 per cent. of that required for operating condensing, and that the boiler pressure must be raised from 150 pounds at the lighting station to about 200 pounds above the atmosphere, and at the power station from 150 to 175 pounds above the atmosphere. It then follows that 30 per cent. of the fuel to operate the engines non-condensing is the increase of the fuel expense imposed by the use of their exhaust for heating.

While this seems like a large proportion of the steam cost to be used for heating purposes, yet it is less than is found to be the case when steam is generated especially for heating independently of the engines. It has been found, in the New England mills, that the fuel consumption is about the same when the exhaust steam is used for heating as it is when the steam for heating is generated independently of the power plant. In many of the mills both steam and water power are used, but a certain quantity of steam is required in the dye-house and elsewhere at all times. When the engines are running, in times of low waters, the exhaust steam is used for heating, and when the mills are operated by water power the heating must be performed by live steam generated for the purpose, and the coal consumption can therefore be compared very readily.

In a valuable paper upon the use of compound engines for manufacturing purposes presented before the American Society of Mechanical Engineers by Mr. Charles T. Main, the relative consumption for various kinds of engines is given upon the assumption of the use of various percentages of the exhaust steam for heating. This paper shows that when all the exhaust steam of an engine is used for heating purposes there is no material economy in using a compound engine, since the back pressure necessary for the heating system prevents the attainment of an expansion ratio otherwise economical.

Taking the case of a 1,000-h. p. engine operating compound-condensing, it is assumed that the fuel cost would be 1.75 pounds per h. p. hour, while if the same engine is run high-pressure, *i. e.,* exhausting into the heating system at atmospheric pressure instead of into a vacuum, the fuel consumption would be 3 pounds per h. p. hour, all the fuel being charged to power. As a matter of fact, however, all the fuel should now not be charged to power, but by far the larger portion of it belongs to the heating account and instead of being a power plant such a combination becomes a heating plant with a side issue consisting of the power end of the establishment. Instead of generating high-pressure steam and then passing it through reducing valves on its way to the heating system, the engines act as reducing valves, and abstract energy, as a sort of by-product, from the steam ultimately used for heating.

That this can be done to advantage hardly appears from Professor Denton's report, since, in order to pay for the cost of heating the 25,000,000 cubic feet of space under consideration, and pay the company a profit of 20 per cent., it would be necessary to make a charge of 35 cents per square foot of radiator per season This corresponds to a charge of $10.02 per ton of coal, used in an isolated plant while as a matter of fact coal can be purchased in Providence for $3.00 per ton, and Professor Denton's own estimate for isolated plants at this rate comes to about 8.7 cents per square foot of radiator surface per season.

Apart from the question of cost involved in the operation of the plant there are other considerations which should be taken into account. The management of central steam plants in large cities has not been found especially easy or profitable; the care of a network of underground piping, with all the losses due to leakage, condensation, etc., is both expensive and unsatisfactory. While the report of Professor Denton assumes to include all the regular expenses of this portion of the scheme, yet experience has shown that the frequent emergency expenses form a large and uncertain element in the cost.

If the heat in the large volumes of steam discharged at the numerous light and power stations could be directly utilized, without the added expense and inconvenience of an extended distribution, it might well be worthy of consideration, but otherwise the combination of a heating and power plant may well be looked upon as a risky experiment.

International Testing Methods.

THE activity and the extent of current interest in the unification and standardization of testing methods is evidenced by the fact that three American engineering journals—the *Engineering News, Engineering Record,* and *Railroad Gazette*—published in full the address of Prof. Mansfield Merriman, as chairman of the American section of the International Association for Testing Materials, at the second annual meeting of the section held at Pittsburg, Pa., in August.

The history of the movement, as sketched by Prof. Merriman, is one of gradually accelerating progress. The first half of this century was a time of "great progress in the theory of elasticity and slow growth in knowledge of the properties of materials under stress." With 1850 began the construction of large testing machines for special purposes; 1870 introduced the period of recognition, by manufacturers, "that physical tests of metals were imperatively necessary in order to secure uniformity of product." Another decade ripened the seeds of the perception that these physical tests must themselves be brought to a uniform basis, and the germ of the present flourishing movement was planted in 1882 by John Bauschinger, when he brought together a number of German experimenters, at Munich, to discuss means for promoting this needed uniformity of testing methods. Successive formal conferences were held at Dresden in 1884, at Berlin in 1886, at Munich in 1888, and at Vienna in 1893. Delegates attended from other countries; wide interest was displayed in the reports of the proceedings, published in Bauschinger's *Mittheilungen;* engineering circles everywhere recognized the importance and value of the discussion—"in short, the movement assumed an international character." The French government had appointed, in 1890, a commission to formulate standard methods for testing materials of construction; its report, presented in 1894, is one of the most valuable contributions to the subject; but France recognized that a commission of a single nationality could not deal finally with the matter, and since 1895 has warmly supported the work of the International Association.

"In 1895, as a result of the four preceding conferences, the fifth conference met at Zurich, all European countries, except Turkey, being represented. The United States government was represented by an army officer and the American Society of Mechanical Engineers by a delegate. At this congress the International Association for Testing Materials was formally organized." "The meeting at Zurich hence assumed an importance far greater than any preceding conference, and it may be called the first congress of the International Association." The second congress was held at Stockholm in 1897, by which time the membership present had grown to 361, representing 18 countries. It was there resolved that the next congress should be held in 1900, in Paris, and the council was "authorized to appoint technical committees to make reports at that time on special problems relating to the work of the Association."

The announcement by the authorities of the Paris Exposition, however, of a special congress on the subject of materials, has made it necessary to reconsider the plan, and either abandon the projected congress, so as to co-operate with the one announced by the Exposition's authorities, or else hold the Association congress in London during the preceding week. The total membership, which in 1897 was 1,169, in 1898 was 1,488 and now is probably nearly 2,000 Germany leads, with 387 members. Next in order come Russia, 315; Austria, 158; England, 83; Switzerland, 83; the United States, 68; Sweden, 68; France, 66—all figures being from the 1898 returns. The United States membership is now approximately 125.

It is interesting to note the distribution of topics to be considered at the 1900 meeting. Nineteen technical questions have been proposed and assigned to international committees. Six of these are on iron and steel—the more important being concerned with international specifications for inspecting and testing; eight are on cement and mortars; and one each on paints, lubricants, stone and slate, tile pipe, and dry rot in wood. The number assigned to iron and steel is not at all surprising, in view of the increasing international range of the trade in structural materials; the space assigned to cement seems "abnormal; but it should be remembered that in the testing of hydraulic cement the personal equation of the observer enters to a far greater degree than in the case of metal, and that its rapidly increasing use demands the immediate perfection of methods which will render comparable the work of different laboratories."

The aims of the Association are so important, and membership in it is so freely open that it is surprising it is not even larger. Sixth place, with a representation of 68 in 1898, is not an adequate showing for a country of the industrial importance of the United States. Every day sees more firmly fixed the custom of buying and selling engineering work and products of every class—raw and manufactured—by exact specifications. Every day, therefore, makes it more vitally necessary that buyers and sellers should reach a standard for the interpretation of the specifications, and a standard method of making the tests. The farther trade goes from home, the greater the need of uniformity of agreement as to methods of inspection and examination. The Association deserves earnest support in its efforts toward establishing those standards and that exactitude of working which not only belong to good engineering, but which serve to establish the confidence between buyer and seller upon which all trade—especially export trade—is based.

The Size of Septic Tanks.

THE *Engineering News* makes the description of the septic tank at Champaign, Illinois, the text for a well considered editorial upon the "proper ratio between tank volume and average daily sewage flow." The question is suggested by the extraordinary difference, as to the ratio, between the Champaign works and those at Exeter. "The Champaign tank has a capacity of only 22,200 gallons, for a dry-weather flow which is already 300,000 gallons a day. * * * With the normal daily flow of 300,000 gallons, the tank is filled 13½ times each 24 hours. * * * In marked contrast to this is the English practice of providing a tank capacity equal to 24 hours' dry-weather flow, which is occasionally reduced to some eight hours by the admission of limited quantities of storm water."

The reviewer naturally remarks that: "Whatever differences may exist between the composition of English and American sewage, and between ground and storm water as the respective diluents, they go only a little way in explaining why the English tanks should be a dozen times as large, relatively, as the one at Champaign. Either the first are too large or the latter too small, providing they are seeking the same ends." Unfortunately, the meagreness of comparable data prevents any close or accurately instructive comparison; so far as the comparison can be made, upon the character of the effluent, it seems to indicate that the Champaign tank is too small—but so little inferior in its working to the Exeter plant that the latter appears to be too large. And this latter the *Engineering News* apparently inclines to hold the worse fault of the two. If its contentions are admitted, excess of size is not only needless—it is disadvantageous.

The functions of the septic tank are "chiefly the removal of suspended matter," partly by sedimentation and partly by anaerobic bacterial action—or putrefaction—breaking down the solid organic matter into forms in which, in the effluent, it is readily nitrified by the aerobic bacterial action succeeding the tank treatment. But "it appears to be a decided disadvantage to allow the anaerobic bacteria to work on the sewage proper longer than is required to break down the organic matter, for if the putrefactive process is carried too far, the changes effected will be inimical to the aerobic bacteria which are to complete the work." The *Engineering News*, therefore, inclines to fix upon four hours as the proper limit of time for the sewage to remain in the tank. "For removal of suspended matter alone, it is very doubtful whether the results obtained after four hours' sedimentation are worth the extra expense for tank capacity, or could not be better attained in some other way." For, as is pointed out, any solid organic matter not broken down at the end of that time will remain in the tank with the sludge, and the anaerobic process will continue in it regardless of drawing off of the effluent, until it finally passes into products escaping at some succeeding emptying of the tank. The conclusion is put in the query: "Can it be profitable to build septic tanks larger than is required for sedimentation?"

It must not be forgotten that the bacterial process can be carried on quite independently of the septic tank. At Sutton, Surrey, where a very high purity of the effluent is claimed, no sedimentation nor tank treatment of any kind is followed; the sewage passes to the bacterial bed after simple straining through a perforated metal screen, to remove the larger solids. The review concludes with a very interesting contrast of English and American ideas regarding stream pollution. For a long time in the United States it received hardly any attention at all; now, "There is a tendency to leave all or nothing to nature; to pollute water most shamefully, until it can be borne no longer, and then to insist on an effluent better than the water into which it is turned. Earlier action and more moderate aims would be far wiser. * * * Our English cousins are not trying to turn their sewage into drinking water, while we have been regarding such a result as at least desirable."

"An effluent better than the water into which it is turned" sounds like an exaggeration, but a case was actually in the courts of Ohio, not many years ago, in which a certain village was enjoined from discharging its sewage effluent into a local stream, the waters of which were many times worse than the effluent and would have been distinctly improved by receiving it. But, after all, it is much wiser to be over-rigorous in excluding impurity than over-lax in admitting it.

Technical Instruction by Correspondence.

Among the valuable papers recently presented before the annual meeting of the Society for the Promotion of Engineering Education was one by Professor Edgar Marburg, of the University of Pennsylvania. upon correspondence schools.

After showing the deficiencies in the general school instruction in the United States and indicating the changes which must come about if the gaps in the existing educational system are to be filled, Professor Marburg proceeded to discuss the subject of instruction by correspondence.

"Sprung from seemingly insignificant beginnings, some ten years since, its growth, notably during the past two or three years, has been little less than phenomenal. It is a significant fact that the correspondence schools have found their largest following among our technical workers, especially those of our shops and factories. Thus a single institution devoted principally to engineering and the mechanic arts claims a total enrollment of upwards of eighty thousand students, a number four times greater than that of only two years ago. Whatever the merit of the system, these figures bear striking evidence that our craftsmen are keenly alive to the defects in their education and are grasping eagerly at such opportunities as present themselves."

As regards the real value of the instruction imparted by these institutions, it is not easy to determine. In the first place they are openly and avowedly money-making enterprises, and while thus altogether as legitimate as any other business enterprise they are on quite a different footing from the regular seats of learning. It is naturally difficult to obtain accurate and precise information concerning private business organizations of this kind, and the statistics which are freely published by the regular schools are either withheld on the grounds of business expediency, or, where furnished, cannot always be accepted with confidence. Testimonials are made prominent, while complete lists of graduates and students are not allowed to appear. Although these matters have no direct bearing on the intrinsic value of the instruction itself yet tactics of this sort naturally give rise to prejudice and distrust. At the same time it is possible to make an investigation, more or less complete, of the method of instruction adopted, and this Professor Marburg appears to have done.

Instruction papers take the place of text books, and with these are provided examination papers containing questions for the student to answer. The answers are then corrected by the instructors, and after a final examination upon the special subject, a certificate of proficency is awarded.

While a certain degree of instruction may thus be imparted, yet it is very certain that only a very limited number of those attempting to study by correspondence can be expected to succeed. It is one of the advantages of the system, however, that it is largely undertaken by those who are really ambitious, and desirous of success. Few men would undertake to acquire an education by laborious night work, without the aid and encouragement which can only come from personal contact and inspiration from the instructor, unless urged on by a strong desire for information and intellectual advancement, and it is just because of this feeling among many of the students that any success is had. Some of these men are terribly in earnest; they see the value of education to others, and are willing to make the fight to obtain it; and to them the correspondence school is the one path by which they can reach the desired goal. Some, of course are led to undertake a course by solicitation, or by the allurements of skilfully prepared advertisements, and most of these fall by the way.

"To sum the matter up, it is believed that any attempt at giving by the correspondence methods a really thorough education to persons who must at the same time follow their daily occupations must end in failure. Narrow and shallow courses may be regarded as the inevitable issue. It should, however, again be emphasized that in the absence of better means, and in so far as these schools are honestly conducted, they hold out opportunities to the many, and rewards to the few well worthy the effort of attainment. And, in conclusion, their highest destiny will have been achieved if by their coming they shall but quicken the birth of a system of popular education—industrial and commercial—worthy in every sense of this great nation."

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, U.S.A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Journal of Science. *m.* New Haven, Conn.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Brick Builder. *m.* Boston, Mass.
Bridges. *m.* Chicago.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phi'a.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Electrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita, *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, U.S.A.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *w.* New York
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Journal of Worcester Pol. Inst. Worcester, Mass.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna
Ores and Metals. *w.* Denver, Colo.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Públicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, U. S. A.
Sanitary Plumber. *s-m.* New York.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, U. S. A.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston.
Terrestrial Magnetism. *qr.* Cincinnati, O.
Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
Trans. Am. Ins. Electrical Eng. *m.* w York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Western Railway Club Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, U. S. A.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Building Stone.

See Civil Engineering, Materials.

Coliseum.

Structural Work of the St. Louis Coliseum. The structural design is based upon the three-hinged arch system. Sectional plans are given and interior view. 1500 w. Eng News—Aug. 10, 1899. No. 29007.

Fire-Escape.

A Novel Fire-Escape. Illustrated description of a fire-escape consisting of a chute and spiral slide. 400 w. Sci Am—Aug. 26, 1899, No. 29179.

Fire-proofing.

Some Deductions from the Evolution in Fire-Proof Construction. Corydon T. Purdy. Historical review of the progress of this form of construction. 1800 w. Br Build—Aug., 1899. Serial. 1st part. No. 29376 C.

Floors.

Fire-Resisting Floors. Illustrates and briefly describes many forms of construction. 1400 w. Fire & Water—Aug. 5 and 12, 1899. Serial. 2 parts. No. 28969.

Foundations.

Cantiliver Foundations of an English Building. Illustrated description of the manner of supporting about half a warehouse under which runs a tunnel. 1000 w. Eng Rec—Aug. 5, 1899. No. 28926.

Opera House.

The New Building of the Comic Opera at Paris (Das Neue Gebäude der Komischen Oper in Paris). An illustrated description of this handsome new auditorium in Paris, with especial reference to the manner in which exits have been provided in case of fire. Two articles. 3000 w. Schweizerische Bauzeitung—July 15, 22, 1899. No. 29264 each B.

Roof Arch.

The Jersey City Trainshed. Illustrated description of the extension of the Jersey City trainshed for the Pennsylvania R. R., and the methods of carrying out the work, with notes on the erection of other large arch roofs. 3500 w. Eng Rec—Aug. 5, 1899. No. 28922.

Skeleton Construction.

Early Skeleton Construction. An examination of the claims of various architects for priority in the use of steel frames to carry outside walls as well as floors and partitions. 1700 w. Eng Rec Aug. 12, 1899. No. 29033.

Stable.

The L. L. Sterns Stables, New York. Illustrated description of the arrangement and fittings of an unusually large private stable and riding hall. 1900 w. Eng Rec—Aug. 19, 1899. No. 29126.

Store.

The Dufayel Department Store (Un-Palais Industriel: L'Administration Dufayel). An illustrated description of the new central building of the Dufayel system of department stores in Paris. 2000 w. Revue Technique—Aug. 10, 1899. No. 29217 D.

HEATING AND VENTILATION.

Exhaust Steam.

See Mechanical Engineering, Steam Engineering.

Gas or Steam.

Gas or Steam Heating. Comments on the labor-saving possible by the use of gas and steam for heating, quoting from articles describing their use in America. 1800 w. Jour Gas Lgt—July 25, 1899. No. 28909 A.

Hot Water.

A Hospital Hot-Water Heating Plant. Illustrated description of an unusually large plant with direct hot-water radiation and a plenum ventilation system. 1700 w. Eng Rec—Aug. 26, 1899. No. 29324.

Low Pressure Hot Water as a Heating Medium. Louis F. Pearson. Read at a meeting of the Inst. of Heat. and Ven. Engs., at Stourbridge. Compares low pressure hot water with other forms of heating apparatus, discussing the necessary qualifications of a desirable heating installation. 1500 w. Plumb & Dec—Aug. 1, 1899. No. 29027 A.

Low Pressure.

Stand Pipes for Low Pressure Heating Boilers (Die Standrohre der Niederdruck-Dampfkessel). A résumé of the statutes in force in various parts of Germany relating to the use of open standpipes for the regulation of pressure on boilers used for cooking, evaporating and similar purposes. Illustrations of various approved methods are given. Two articles. 5000 w. Gesundheits-Ingenieur—July 15, 31, 1899. No. 29253 each B.

We supply copies of these articles. See introductory.

Mill Plant.

A Mill Ventilating and Heating Plant. Illustrated description of a hot-blast plant for a large paper mill. 1000 w. Eng Rec—Aug. 12, 1899. No. 29038.

Moisture.

The Influence of Moisture in the Air upon the Health of Occupants of Closed Rooms (Die Bedeutung des Wasserdampfgehaltes der Luft für die Gesundheit der im Geschlossenem Raum sich Aufhalten den Menschen). H. C. Nussbaum. Emphasizing the importance of maintaining the proper degree of humidity in artificially warmed rooms. 2500 w. Gesundheits-Ingenieur—July 31, 1899. No. 29254 B.

Ventilation.

Upward and Downward Ventilation. An explanation of their relative advantages. 500 w. Eng Rec—Aug. 26, 1899. No. 29325.

Warming.

See Electrical Engineering, Heating.

PLUMBING AND GAS FITTING.

Cooking.

Cooking on a Large Scale (Massenkochanlagen). M. Grellert. A very full discussion of the arrangement of plants for cooking food in large quantities by steam. Two articles. 7500 w. Gesundheits-Ingenieur—July 31, Aug. 15, 1899. No. 29255 each B.

Regulations.

An Excellent Set of Plumbing Regulations. Gives the plumbing ordinance in effect at Moline, Ill. 6000 w. Dom Engng—Aug., 1899. No. 29135 C.

Sanitation.

Domestic Sanitation. W. Watkins. Read before the Sanitary Inspectors' Assn., during the Conference at Lincoln, England. Considers various appliances in household use, and the surroundings that affect the soil and healthfulness of the home. 3300 w. Builder—Aug. 12, 1899. No. 29151 A.

Soldering.

The Art of Soldering. From *The Textile Journal,* Bombay, India. Some points bearing on this subject and the materials used. 1700 w. Dom Engng—Aug. 1899. No. 29134 C.

MISCELLANY.

Lightning Protection.

The Protection of Structures from Lightning. Information from a pamphlet recently issued by the U. S. Weather Bureau bearing upon this subject. 1800 w. Eng News—Aug. 10, 1899. No. 29011.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

The Alexander III. Bridge Over the Seine (Pont Alexandre III. sur la Seine). E. Rouyer. Describing especially the methods of casting the steel voussoirs, and of assembling the arches prior to erection. 4000 w. 1 plate. Génie Civil—July 15, 1899. No. 29200 D.

Aqueduct.

The Oudan Aqueduct Bridge (Le Pont-Rivière d'Oudan). M. Mazoyer. An illustrated description of the iron aqueduct by which the Oudan is carried across Roanne-Digoin canal. 2000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29212 E + F.

Berne.

The Ironwork of the Kornhaus Bridge at Berne (Die Eisenkonstruktion der Kornhausbrücke in Bern). A very complete account of the structural work of the great arch bridge over the Aar at Berne, of 377 feet span. Three articles, 6000 w. Schweizerische Bauzeitung—July 8, 15, 22, 1899. No. 29262 each B.

Boston Bridge.

The Fort Point Channel Bridge, Boston. Illustrated description of a rolling lift bridge with three double track spans 85 to 113 feet long. 1200 w. Eng Rec—Aug. 19, 1899. No. 29119.

Counterstresses.

Insufficient Provision for Counterstresses in Railroad Bridges. Henry S. Pritchard. Presents considerations showing that provision should be made for counterstresses from some increase in the live loads, and such provision should be clearly stated in the specifications. 1500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29300 E.

Double Deck.

Double-Deck Bridge at Wells St., Chicago. Illustrated detailed description of a bridge carrying the Northwestern Elevated Ry. over the tracks of the Chicago & Northwestern Ry. 1200 w. Eng News—Aug. 24, 1899. No. 29187.

Erection.

The Erection of the Metallic Super-structures of the Bridges over the Ciron and the Dropt (Mise en Place des Nouveaux Tabliers Métalliques des Ponts sur le Ciron et le Dropt). With a plate of details showing the construction of the false works and the manner of removing the old bridges simultaneously with the erection of the new. 1500. 1 plate. Rev Gen de Chem de Fer—July 1, 1899. No. 29234 F.

Hinged Arch.

Comparison of Weights of a Three-Hinged and a Two-Hinged Spandrel-Braced Parabolic Arch. C. W. Hudson. Results of a comparison to determine the exact relative economy as regards weight of metal as given, with a brief explanation of the method used in calculating the stresses in the two-hinged arch. Ill. 2000 w. Pro Am Soc of Civ Engs—August, 1899. No. 29301 E.

Hinged Arches for Masonry Bridges (Ponts en Maçonnerie Articulés). Especially devoted to the construction of the hinge joints to be imbedded in the masonry at the spinnings and the key of articulated arch bridges. 1200 w. Génie Civil—Aug. 12, 1899. No. 29207 D.

Theory and Calculation of the Two-Hinged Arch. Alex. Rice McKim. A mathematical treatment deriving the equations of condition and applying them to a practical example. 2800 w. Eng News—Aug. 24, 1899. No. 29186.

India.

Bridge Over the Indus. Fine illustration, with brief description, of the bridge across the Indus, on the Kotri Rohri section of the Indian State Railway. 500 w. Engng—July 28, 1899. No. 28983 A.

Launching.

The J. F. Lepine Bridge (La Pont J. F. Lepine). L. Biette. Giving a full description of the manner in which the bridge was constructed and launched over a cutting 142 feet wide, containing 11 railway tracks, without interrupting trains. 7500 w. 2 plates. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29213 E + F.

Lift Bridge.

The Scherzer Rolling Lift Bridge Over the Fort Point Channel, Boston. Illustrated description of an engineering work of interest. 800 w. R R Gaz—Aug. 4, 1899. No. 28939.

Loads.

General Criterion for Position of Loads Causing Maximum Stress in any Member of a Bridge Truss. F. C. Kunz. Discussion of paper by L. M. Haskins. 500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29307 E.

Wheel Concentrations and Fatigue Formulas in Bridge Design. Informal discussion at the annual convention, June 27, 1899. 12500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29303 E.

Niagara.

The Bridges of Niagara Gorge. Description, with illustrations of picturesque bridges which span the gorge, connecting the American and Canadian shores. 2200 w. Ill Car & Build—July 21, 1899. No. 28873 A.

The New Highway Bridge Over the Niagara River (Die Neue Strassenbrücke über den Niagara-Fluss). F. C. Kunz. A very fully illustrated account of the construction of the great Clifton arch of 840 feet span, over the Niagara river. Two articles. 1 plate. 10000 w. Zeitschr d Oesterr Ing a Arch Ver—July 28, Aug. 4, 1899. No. 29242 each B.

Plate Girders.

The Erection of Large Plate Girder Spans. Charles H. Wright. Illustrates and describes the manner of handling and the transportation of these huge masses of steel. 1500 w. Bridges—July, 1899. No. 28959 C.

Removal.

Removing a Bridge. Illustrates and describes the removal of the Chicago Terminal Transfer Bridge. 700 w. Ry Age—Aug. 18, 1899. No. 29140.

Suspension.

The Lewiston and Queenston Suspension Bridge. Illustrated description of a suspension bridge of 1,040 feet span, supported by the cables of an old demolished bridge, pieced out with eye-bars and stiffened by a truss of unusual design. 5000 w. Eng Rec—Aug. 26, 1899. No. 29319.

Viaduct.

The construction of the Viaur Viaduct (Construction du Viaduct du Viaur). M. Thery. A general description of the great steel arch over the Viaur valley, span 220 metres; with plates of the proposed and executed work. 8000 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29210 E + F.

CONSTRUCTION.

Foundations.

See Architectural Engineering, Construction.

Mountain Torrents.

Some Mountain Torrents of Switzerland. On the work necessary to defend against or regulate a torrent. Treats of cases where the water cuts away the ground on account of transverse currents, and where the torrent bed is gradually deepening. Ill. 1600 w. Engr, Lond—Aug. 4, 1899. Serial. 1st part. No. 29072 A.

Pile Driver.

A Railway Pile Driver. G. W. Smith. Describes the important work done in the maintenance of bridges, and in emergencies, and describes a recently constructed pile driver for the Chicago, Milwaukee and St. Paul Railway Co. Ill. 5000 w. Jour W. Soc of Engs—June, 1899. No. 28940 D.

Reservoirs.

Covered Reservoirs at Pasadena, Cal. T. D. Allin. Illustrates and describes the work of covering the reservoirs, five being covered with flat roofs. 1600 w. Eng News—Aug. 17, 1899. No. 29101.

Retaining Wall.

The Pressure of Earth Upon a Retaining Wall (Poussée des Terres sur un Mur de Soutènement). M. Hisely. A mathematical treatment, developing a general graphical solution of the problem applicable to any character of load. 5000 w. Aun des Ponts et Chaussées—1 Trimestre, 1899. No. 29211 E + F.

Roads.

Notes on the Construction of Mountain Roads (Beitrag zur Anlage von Gebirgs-Kunststrassen). J. Rossmanith A mathematical examination of the considerations which enter into the construction of mountain highways, including questions of grade, curve and capacity. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1899. No. 29,-251 D.

Roadways Across Bogs. R. J. Howley. Describes the methods of building embankments for railways and highways across Irish bogs. 2200 w. Eng Rec—Aug. 19, 1899. No. 29121.

State Road Construction, New York. Extracts from a specification for a New York State highway, which enters into details in an unusually minute manner. 1900 w. Eng Rec—Aug. 5, 1899. No. 28923.

Subsidence.

See Mining and Metallurgy, Mining.

Transporter.

The Transporter at Bizerte, Tunis (Bizerte et son Pont Transbordeur). G. Leugny. An illustrated account of the suspension tramway ferry over the entrance to the harbour of Bizerte in Tunis. 1500 w. Revue Technique—July 25, 1899. No. 29216 D.

Tunnel.

North Bessemer Tunnel. F. E. House. Illustrates and describes the methods of construction used in the Pittsburg, Bessemer & Lake Erie Tunnel. Also discussion. 4200 w. Pro Engs Soc of W. Penn—June, 1899. No. 29385 D.

The Mersey Tunnel. Historical account of the undertaking and the difficulties encountered. 1800 w. Ill. Car & Build—July 21, 1899. No. 28872 A.

The Piercing of the Simplon. Interesting information relating to this important work, its present actual condition, etc., giving a brief review of its history and development. 1500 w. Engr, Lond—Aug. 11, 1899. No. 29162 A.

Tunneling.

The Hastings Tunneling Shield. An illustrated description of the latest form of tunneling shield, which is being used in the 20 ft. intercepting sewer at Chicago. 2000 w. Eng News—Aug. 3, 1899. No. 28933.

HYDRAULIC AND MARINE.

Breakwater.

Repairs of the Breakwater at Alderney. Bernard O'Driscoll Townshend. Presented to the British Inst. of Civ. Engs. Illustrates and describes repairs in which large concrete blocks were substituted for granite. 1200 w. Eng News—Aug. 10, 1899. No. 29010.

Canada.

Canadian Water Power and Its Electrical Product in Relation to the Undeveloped Resources of the Dominion. Thomas C. Keefer. Presidential address before the Royal Society of Canada. Attempts to give an approximate estimate of the quantity and value of the great water power available. 4000 w. Can Engr—Aug., 1899. Serial. 1st part. No. 29042.

Canals.

Mr. Hewitt on the Canals of New York. Reply of Mr. Abram S. Hewitt to the letter of inquiry sent out by the committee. Thinks there is no justification for the expenditure of any considerable sum of money for their enlargement. 1100 w. R R Gaz—Aug. 4, 1899. No. 28936.

What Had Best Be Done With the New York State Canals? A Symposium. Editorial summary of replies to the inquiry letter sent out by the expert commission appointed by the Governor, and the arguments presented. 4400 w. Eng News—Aug. 3, 1899. No. 28932.

Dam.

The Assouan Dam. . Illustrations showing the progress of the irrigation works in course of construction on the Nile, with extracts from reports of engineers resident on the works. 1000 w. Engr, Lond—Aug. 11, 1899. No. 29157 A.

East Jersey.

The Pumping and Power Station of the East Jersey Water Co., at Little Falls, N. J. Illustrates and describes the plant which is a combination of water and steam power, and the works connected. 2500 w. Eng News—Aug. 3, 1899. No. 28930.

Flow.

The Hele-Shaw Experiments and the Stream-Line Theory. Marston Niles. A letter discussing objections to the conclusions drawn from these experiments and pointing out what the writer considers the defects of the system. 4200 w. Engng—July 28, 1899. No. 28984 A.

Hydrography.

Recent Hydrographical Surveys. On recent work of the hydrographical department of the British Admiralty, and the great benefit accruing from this work. 2500 w. Engr, Lond—Aug. 11, 1899. No. 29156 A.

Reservoirs.

Covered Reservoirs and Their Design. Freeman C. Coffin. A brief consideration of a few types of the reservoirs of this class which have been built, a study of the elements which enter into the design and an investigation of the cost of various sizes and depths. Ill. 9500 w. Jour Assn of Engng Socs—July, 1899. No. 29377 C.

Removal of a Famous Engineering Landmark. Gives illustrations of the 42nd st. reservoir in New York city and a brief account of the scheme of which it formed a part, and its removal now in progress. 1100 w. Sci Am—Sept. 2, 1899. No. 29390.

The Conditions of Resistance of Masonry Dams for Reservoirs (Les Conditions de Résistance des Barrages des Réservoirs en Maçonnerie). M. L. Barbet. A mathematical treatment for various profiles, with diagrams showing the lines of pressure in each case. 7000 w. 1 plate. Ann des Ponts et Chaussées —1 Trimestre, 1899. No. 29209 E + F.

Water Mains.

System for Preventing the Bursting of Pipes. Describes and illustrates a recently patented system depending on the elastic cushioning of the pipes at intervals with air, by means of air domes with inclined planes, opposite the mouth of the storage dome. 1500 w. Am Mfr & Ir Wld—Aug. 24, 1899. No. 29312.

Water Power.

The Development of American Water Powers. Abstract of historical paper by John T. Fanning, giving data concerning colonial and early national hydraulic works, and explaining features of present practice. 3000 w. Eng Rec—Aug. 19, 1899. No. 29125.

Water Storage.

Application of the Principle of Water Storage to New England Rivers. J. Herbert Shedd. Slightly condensed from a paper read before the American Paper & Pulp Assn. at the New York meeting. Enumerates the advantages which have made this section of the country eminent in manufacturing, and shows the large resources yet undeveloped, and the favorable conditions for water storage. 4000 w. Eng News—Aug. 10, 1899. No. 29014.

Water Supply.

Artesian Wells for the Water Supply of Chatham and Madison, N. J. Louis L. Tribus. A description of the methods adopted and of the geological peculiarities resulting from glacial action and deposit. 900 w. Eng News—Aug. 10, 1899. No. 29012.

London (Welsh) Water Supply. R. E. Middleton. Arguments against the introduction of a water supply from Wales. Followed by discussion. 5500 w. Jour San Inst—July, 1899. No. 28971 E.

New York's Water Supply. Editorial on the project of the Ramapo Water Co. to supply 200,000,000 gals. daily from works to be designed and built in three years. Also an official statement of the work. 7800 w. Eng Rec—Aug. 26, 1899. No. 29318.

The Future Water Supply of New York City. Editorial discussion of the scheme of the Ramapo Water Co.. and of other possibilities for increasing the supply. 3000 w. Eng News—Aug. 24, 1899. No. 29188.

The Water Supply of Cities. C. F. Ulrich. Read at the Columbus meeting of the Am. Water-Works Assn. Discusses the changed conditions which demand a much more liberal supply, the means of securing purity and freedom from disease germs, the advantages of large reservoirs, filtration, etc. 3200 w. Fire & Water—Aug. 12, 1899. No. 29047.

The Water Supply of the City of Glasgow. Benjamin Taylor. A beautifully illustrated article showing the construction of the great aqueduct by which the water of Loch Katrine is brought to the city of Glasgow by gravity. 4000 w. Engineering Magazine—Sept., 1899. No. 29294 B.

Water Tower.

Compton Hill Water Tower, St. Louis. Illustrated description of a standpipe 6 feet in diameter and 128 feet high, enclosed in a masonry tower about 171 feet high. 2100 w. Eng Rec—Aug. 5, 1899. No. 28925.

Water-Works.

The Water-Works of Cambridge, Mass. Illustrated description of the recently enlarged works of the only city within the metropolitan district of Massachusetts which will not obtain a supply from the works of the Metropolitan Water Board. The paper gives descriptions of pipe line and dam details. 3000 w. Eng Rec—Aug. 26, 1899. No. 29321.

See also Civil Engineering, Municipal.

MATERIALS.

Building Stone.

Bridge Stones of the Central States. C. A. Raymond. Calls attention to the magnitude of this industry, and gives information concerning a few of the strata furnishing building or bridge stone. Ill. 3400 w. Bridges—July, 1899. No. 28958 C.

Cements.

Limes, Mortars, Cements and Concretes. Fred T. Hodgson. Information concerning these products and history of their use. The present article is devoted to the first two. 2000 w. Bridges—July, 1899. Serial. 1st part. No. 28960 C.

The Shock and the Explosion Tests of Cement. Eugene Ackermann. Translated from *Chemiker-Zeitung*. Suggestions for tests of cements to be used in fortification works. 1500 w. Stone—August, 1899. No. 29382 C.

Concrete.

Experiments to Determine the Effect of Freezing on Concrete. Walter A. Rogers. Describes tests made from which it is concluded that concrete work with cement possessing qualities similar to those tested may be carried on safely during moderately cold weather by using proper precautions. Discussion. 2500 w. Jour W Soc of Engs—June, 1899. No. 28941 D.

On the Theory of Concrete. Discussion of the paper of George W. Rafter. 9000 w. Pro Am Soc of Civ Engs—August, 1899. No. 29310 E.

Tests of Frozen Concrete. Report of experiments made by W. A. Rogers on Portland and natural cement concretes made with and without salt and kept under different temperature conditions. 1300 w. Eng Rec—Aug. 26, 1899. No. 29322.

Reinforced Cement.

Theory and Recent Applications of Reinforced Cement (Théorie et Applications Nouvelles du Ciment Armé). Harel de la Noë. A general discussion of the application of the elastic theory to structures of metal imbedded in concrete, with especial reference to the work of the writer at Le Mans. 5000 w. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29208 E + F.

Tanks.

Steel vs. Wood Tanks. Theodore W. Snow. Considers the class and durability of material and the cost, considering the wood tank better able to withstand neglect than the iron tank. Discussion, correspondence and illustrations. 7500 w. Jour W Soc of Engs—June, 1899. No. 28942 D.

Timber.

Preservation of Timber. Samuel M. Rowe. Reviews facts gained by study, experience and observation, and the processes used. 2300 w. Jour W Soc of Engs—June, 1899. No. 28943 D.

MEASUREMENT.

Field Notes.

Field Notes of a Civil Engineer—Do They Belong to His Client or to Himself? J. Vander Hoek. A discussion of this subject giving cases as illustrating certain points. 8000 w. Jour Assn of Engng Socs—July, 1899. No. 29378 C.

Micrometer.

A New Optical Distance-Measuring Device (Ein Neuer Optischer Distanzmesser.) A. Tichy. A description of the quadruple micrometer of Tichy and Starke, a form of micrometer for use in the telescope for measuring distances on the principle of the stadia system. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 1899. No. 29240 B.

MUNICIPAL.

Garbage Cremation.

Refuse Furnaces. George Watson. Abstract of a paper before the Institution of Civil Engineers, England, on the practical features of managing cremators. 2500 w. Eng Rec—Aug. 26, 1899. No. 29323.

Havana, Cuba.

The Sanitary Condition and Requirements of Havana, Cuba. E. Sherman Gould. Describes the natural conditions due to site, soil, climate, etc., and the artificial conditions created by the inhabitants, the work since the American occupation, and the permanent work needed. 2500 w. Eng News—Aug. 3, 1899. No. 28931.

Municipal Ownership.

Municipal Ownership of Water-Works. John B. Heim. States the results at

Madison, Wis., showing the advantage when they can be placed on a business basis. 1500 w. Munic Engng—August, 1899. No. 28897 C.

The Prohibition of Municipal Ownership of Michigan Street Railways. A statement of the reasons for the constitutional prohibition of the municipal ownership of street railways in the State. 1900 w. Eng Rec—Aug. 5, 1899. No. 28921.

Paris.

The Present Condition of the Sanitation of Paris (Etat Actuel de l'Assainissement de Paris). With map and profile showing the extent and nature of the sewerage improvements executed from 1895 to 1899. 2000 w. Génie Civil —July 22, 1899. No. 29202 D.

Pavements.

Notes on Indianapolis Pavements. Gives the experience with brick, wood and asphalt pavements. 1000 w. Eng Rec—Aug. 5, 1899. No. 28924.

Repairs to Asphalt Pavements. A decision of the U. S. Circuit Court of Appeals concerning various methods of repairing asphalt pavements involving the heating of the old surface and the substitution of fresh material for old. 1800 w. Eng Rec—Aug. 19, 1899. No. 29122.

Porto Rico.

Sanitary Work in Porto Rico. L. P. Davison. Describes the conditions existing and the work in progress. 1800 w. Sci Am Sup—Aug. 26, 1899. No. 29182.

Refuse Disposal.

Refuse Disposal and the Results Obtained from a Six Months' Working of the Refuse Destructor at Torquay. Henry A. Garrett. Read before the Inst. of Mech. Engrs., England. A record of the writer's experience at Torquay, with attention to important points in connection with refuse disposal. 2500 w. Engng—Aug. 18, 1899. No. 29361 A.

Septic Tank.

The Septic Tank of the Champaign Sewerage System. Arthur N. Talbot. Explains the process and the conditions under which the tank named is operated. Also editorial on "The Proper Size for Septic Sewage Tanks." 4500 w. Eng News—Aug. 17, 1899. No. 29103.

Sewage Disposal.

Baltimore Sewerage. A review of the final recommendations of a commission appointed to consider the sewerage and sewage disposal of Baltimore, where the oyster interests seriously interfere with usual practice. 1100 w. Eng Rec—Aug. 26, 1899. No. 29320.

Irrigation with Paris Sewage. A notice of the unusually high rate of irrigation per acre which must be adopted for a portion of the sewage farms in order to comply with the law. 900 w. Eng Rec—Aug. 5, 1899. No. 28920.

The Present Condition of Sewage Disposal at Paris. An outline of the progress since 1895, in the works executed for diverting the sewage of Paris from the River Seine. 1000 w. Eng News—Aug. 17, 1899. No. 29104.

Sewerage.

The Influence of Sewage on Cement. A résumé of experiments made at Lehigh University. 1100 w. Eng Rec—Aug. 19, 1899. No. 29124.

The Sewerage of Concord, Mass. Illustrated description of work involving a circular vaulted reservoir of peculiar construction, constructed with much difficulty. 1000 w. Eng Rec—Aug. 19. 1899. No. 29123.

Sewer Air.

Sewer Air: Mistaken Ideas Regarding It. Leonard P. Kinnicutt. Discusses the chemical composition and what is known of the micro-organisms, and claims there is little danger from the amount that ever enters dwellings. 3200 w. Munic Engng—August, 1899. No. 28896 C.

Sewers.

The Intercepting Sewers of Chicago. Describes the work done to keep sewage from Lake Michigan, and illustrates a novel form of shield used on one of the tunnels. 3000 w. Eng Rec—Aug. 12, 1899. No. 29035.

Town Plan.

The Project of a Residence Colony on the Cobenze Property (Das Project einer Villencolonie auf der Gutsbesitzung Cobenze). Karl Mayreder. An account of the extensive plans for laying out a residence park in the vicinity of Vienna. 4500 w. 1 plate. Zeitschr d Oesterr Ing w Arch Ver—July 14. 1899. No. 29239 B.

Stream Contamination.

Stream Contamination and Sewage Purification. Informal discussion at the annual convention. June 28, 1899. 13500 w. Pro Am Soc of Civ Engs—August, 1899. No. 29304 E.

Water Consumption.

The Consumption of Water per Head in Different Towns. Discusses the causes of the great variation, the need of regulations, and of proper measuring apparatus. 1800 w. Jour Gas Lgt—Aug. 8, 1899. No. 29093 A.

Water Supply.

See Civil Engineering, Hydraulic.

Water Works.

The Appraisal of the Gloucester Water-Works. A review of the principles adopted by the commissioners appointed to bear testimony and appraise the value of a private water company. 1700 w. Eng Rec—Aug. 19, 1899. No. 29120.

MISCELLANY.

China.

America, England and Germany as Allies for the Open Door. John Barrett. A full review of existing conditions with regard to the development of engineering and commercial advancement in the Far East, showing the identity of interests of the three Powers, and the need of immediate action for the preservation of the vast markets which it is equally to the interests of all to maintain in their entirety. 4000 w. Engineering Magazine—September, 1899. No. 29290 B.

ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The Cairo-Cape Telegraph. An illustrated account of the building of the lines of the African Trans-Continental Telegraph Company. 1500 w. Elec Rev, N. Y.—Aug. 16, 1899. No. 29086.

Coherers.

See Electrical Engineering, Electro-Physics.

Fire Alarms.

What Are the Increased Benefits of the Storage Battery for Fire Alarm Systems? Morris W. Mead. Read at the Syracuse, N. Y., meeting of the International Assn. of Fire Engineers. Considers the advantage of the storage battery over the gravity or other primary cell, and the storage battery controlling board and its special adaptation to fire telegraph service. 1200 w. Fire & Water—Aug. 26, 1899. No. 29326.

Protection.

Protection of Telephone Apparatus. H. P. Clausen. Discussion of the false notions held as to the proper conditions under which telephone apparatus should be provided with protective devices. Ill. 1800 w. Elec Engng—August, 1899. Serial. 1st part. No. 29117.

Space Telegraphy.

Telegraphy by Means of the Electric Light. Brief explanation of the system patented by Carl Zickler. 700 w. Elec, Lond—Aug. 11, 1899. No. 29145 A.

Wireless Telegraphy. Jas. L. Adams, Jr. Describes experiments made and the effects produced. Ill. 1500 w. Elec World—Aug. 19, 1899. No. 29092.

Telephones.

Automatic Telephone Exchange at Augusta, Ga. Lee Campbell. An illustrated description of the Augusta system. 1500 w. Elec Wld—Aug. 26, 1899. No. 29313.

Automatic Telephones of the German Post Office (Die Fernsprechautomaten der Reichs-Postverwaltung). A description with details of the slot-controlled telephones used by the German post-office. 2000 w. Eektrotech Zeitschr—Aug. 3, 1899. No. 29273 B.

Richmond Home Telephone Company. A. E. Dobbs. An illustrated description of the fine construction at Richmond, Ind. The system adopted is that of complete metallic service to each subscriber. 1800 w. Elec Engng—August, 1899. No. 29118.

Transmitting.

Methods of Transmitting Intelligence. George D. Shepardson. Interesting account of the development of methods for near or remote points. 5500 w. Elec Rev, N. Y.—Aug. 2, 1899. No. 28907.

DISTRIBUTION.

Charges.

On the Determination of a Fair Return for Current Supply. C. W. Hutton. Read before the Pacific Coast Elec. Trans. Assn. Suggestions of a method for establishing a rate based on the length of time a customer uses the current. 3300 w. Jour of Elec—July, 1899. No. 29041.

Switchboards.

The Construction of Switchboards. William Baxter, Jr. Discusses the arrangements of switchboards designed for plants of large capacity. Ill. 1600 w. Am Mach—Aug. 24, 1899. Serial. 1st part. No. 29193.

The General Arrangement and Connection of Apparatus on Switchboards. William Baxter, Jr. Explains the general arrangement of the switches, instruments and other apparatus, showing how they are connected with each other and with the generators and the external circuits. Ill. 1700 w. Am Mach—Aug. 10, 1899. Serial. 1st part. No. 29020.

Wiring.

Concentric Wiring. Mervyn O'Gorman. Illustrates this system of wiring and sets forth its advantages. 3000 w. Elec Wld & Elec Engr—Aug. 12, 1899. No. 29016.

Works Distribution.

Electric Power Distribution in a German Workshop. O. Lasche, in *Zeitschrift des Vereins Deutscher Ingenieure.* Abstract translation, with illustrations, describing the power distribution of the Allgemeine Elektricitäts Gesellschaft. and also individual driving. 1700 w. Elect'n, Lond—July 21, 1899. No. 28-868 A.

ELECTRO-CHEMISTRY.

Battery.

Historical Notes on the Primary Battery. W. R. Cooper. From a book to be published by *The Electrician* Printing and Publishing Co. Gives the early history and development. 1200 w. Elect'n, Lond—Aug. 18, 1899. No. 29345 A.

Calcium Carbide.

Three-Phase Currents in the Manufacture of Calcium Carbide in Italy. Cesare Pio. Gives data relating to the construction and operation of the furnaces in which three-phase currents are used, the production and cost. Ill. 3000 w. Elec Wld & Elec Engr—Aug. 5, 1899. No. 28934.

See also Gas Engineering.

Desilverizing.

The Cost of the Electrolytic Desilverization of Argentic Lead (Prix de Revient de la Désargentation Electrolytique des Plombs Argentifères). A detailed examination of the Tommasi process, showing the various items of cost, and deducing the total cost to be about 7 francs per ton of lead treated. 1500 w. Electricièn—June 17, 1899. No. 29265 B.

Electrolysis.

The Electrolytic Separation of Lean Gold-Silver Alloys (Ueber die Elektrolytische Scheidung Armen Güldischen Silbers). Dr. A. Dietzel. A paper read before the German Electrochemical Society, giving details of an apparatus and method for separating small proportions of gold from silver alloys. 2000 w. Zeitschr f Elektrochemie—July 27, 1899. No. 29278 G.

Progress.

The Progress of Electro-Chemistry in 1898. H. Borus. Begins a review of the work accomplished by various investigators. 3000 w. Eng & Min Jour—Aug. 12, 1899. Serial. 1st part. No. 29031.

Statistics.

The Future of Electrochemical Technology (Ueber den Gegenwärtigen Stand der Elektrochemischen Technik). Prof. H. Borchers. A paper before the German Electrochemical Society giving very full statistics of present and proposed electrochemical works in various parts of the world, with discussion. 6000 w. Zeitschr f Elektrochemie—July 20, 1899. No. 29277 G.

ELECTRO-PHYSICS.

Carbon.

The Energy of Carbon. C. J. Reed. Pure carbon alone is considered, and a study is made of the possibilities and limitations in transformnig the energy of carbon into available forms of energy. 2100 w. Elec Wld & Elec Engr—Aug. 12, 1899. Serial. 1st part. No. 29017.

Coherers.

A Self-Recovering Coherer and the Study of the Cohering Action of Different Metals. J. Chunder Bose. Read before the Royal Soc. Account of researches on the cohering properties of various metals when exposed to electric radiation. 4000 w. Elect'n, Lond—July 21, 1899. No. 28869 A.

Conductivity.

The Dielectric Cohesion of Rarefied Gases (Sur la Cohesion Diélectrique des Gaz Raréfiés). E. Bonty. A further communication to the French Academy, describing the author's experiments with electric currents in exhausted tubes. 1200 w. Comptes Rendus—July 24, 1899. No. 29225 D.

The Electrolytic Conductivity of Rarefied Gases (Les Gaz Raréfiés Possedent-ils la Conductivité Electrolytique?). E. Bonty. A communication to the French Academy, giving the results of experiments with Crookes' and Geissler's tubes. 1500 w. Comptes Rendus—July 17, 1899. No. 29222 D.

Interrupter.

Concerning Wave Currents (Ueber Wellenströme). Dr. C. Heinke. A discussion of the "wave," or intermittent current in connection with experiments upon the Wehnelt interrupter. Two articles. 10000 w. Electrotech Zeitschr—July 20, 27, 1899. No. 29269 each B.

The Wehnelt Current-Interrupter (Der Elektrolytische Stromunterbrecher). Von Dr. A. Wehnelt. A description of the Wehnelt apparatus, especially in connection with the induction coil for the purpose of radiography. 2500 w. Elektrochemische Zeitschr—July, 1899. No. 29280 G.

Magnetism.

Magnetism and Molecular Rotation. Lord Kelvin. Paper, editorial and correspondence. 4500 w. Elect'n, Lond—Aug. 4, 1899. No. 29065 A.

The Magnetic Field in the Interior of a Hollow Cylinder Traversed by a Current (Sur le Champ Magnétique à l'Interieur d'un Cylindre Creux Parcouru par un Courant). W. de Nikolaieve. A short communication to the French Academy showing the author's demonstration of the existence of a magnetic couple in the interior of a tubular current. 600 w. Comptes Rendus—July 24, 1899. No. 29224 D.

Phillips Phenomenon.

A Mathematical Investigation of the Phillips Phenomenon. George W. Walker. States briefly the experiment and gives a general explanation, and the mathematical treatment of the question. 1400 w. Elect'n, Lond—Aug. 18, 1899. Serial. 1st part. No. 29346 A.

Resistance.

On the Electrical Resistivity of Mixtures of Plumbago and Clay. J. A. Fleming. Reports experiments by which the author found that by varying the proportions of clay and blacklead any required resistivity could be produced within very wide limits. 1800 w. Elect'n, Lond—July 28, 1899. No. 28980 A.

Salt Vapors.

The Electrical Conductivity of Flames Containing Salt Vapors. Harold A. Wilson. Abstract of a paper read before the Royal Soc. Describes experiments undertaken following up the analogy between the conductivity of salt vapors and Rontgenized gases, and getting some information about the velocity of the ions in the flame itself. 1200 w. Elect'n, Lond—July 21, 1899. No. 28870 A.

GENERATING STATIONS.

Accounts.

Corporation Electricity Works Accounts. H. M. Stevens. Read at the Corporate Treasurers' and Accountants' Institute, England. A discussion of some points in the form prescribed by the Board of Trade. 3500 w. Elect'n, Lond—Aug. 11, 1899. No. 29148 A.

Accumulators.

The Accumulator Tests of the Automobile Club of Paris (Concours d'Accumulateurs de l'Automobile Club de France). A. Bainville. The beginning of a review of the various accumulators tested, with a description of the manner of making the trials. Serial. Part 1. 1000 w. L'Electricièn—June 24, 1899. No. 29267 B.

Alternators.

The Alterations to the Brush Alternators at Bankside Station. Ernest Kilburn Scott. Describes alterations made to the alternators at this London electric-lighting station. Ill. 1200 w. Elect'n, Lond—Aug. 18, 1899. No. 29344 A.

Barrow-in-Furness.

Barrow-in-Furness Electricity Works. Illustrated description, with information concerning this seaport town of 60,000 inhabitants. The system of supply adopted is the high-tension, continuous-current generation, with motor-transformers. 4500 w. Elec Engr, Lond—Aug. 4, 1899. No. 29063 A.

Direct Connection.

A 2000-H. P. Tri-Compound Engine Direct Connected to a 10,000-Volt Ferranti Generator. Describes a novel design of steam engine in operation at Deptford, Eng., at the works of the London Electric Supply Corporation. 600 w. Eng News—Aug. 10, 1899. No. 29009.

Exhaust Steam.

See Mechanical Engineering, Steam Engineering.

Isolated Plants.

Saving in Isolated Plants. Alton D. Adams. Estimates of cost are discussed, and the difference in cost between light from isolated plants and public supply. 1400 w. Sci Am—Aug. 19, 1899. No. 29087.

Leith, Scotland.

Leith Corporation Electric Supply Works. Illustrates and describes a successful station completed in very short time. 2200 w. Elect'n, Lond—Aug. 11, 1899. No. 29147 A.

Louisville Station.

The Central Station of the Louisville Electric Light Co. George Wilbur Hubley. A description, with illustrations, of a comprehensive system generating alternating, 500-volt power and series arc current. 4300 w. Am Elect'n—August, 1899. No. 28860.

Mine Plant.

Electrical Installation in Coal Mines. Harry N. Gardner. Comments on the conditions and causes that have deterred operators from installing electric plants, and describes work that has been efficient and profitable. Ill. 2500 w. Am Elect'n—August, 1899. No. 28861.

The La Bella Mill Water and Power Company's Plant. Describes a plant in the Cripple Creek region of Colorado for running railways and operating hoists, pumps, compressors, etc., in mines. 2000 w. Elec Rev, N. Y.—Aug. 23, 1899. No. 29172.

Piping.

See Mechanical Engineering, Steam Engineering.

Pittsburg.

See Street and Electric Tramways.

Plymouth, Eng.

Plymouth Electric Supply Works. An illustrated account of recently completed works, the first in England to combine the running of the tramways and the lighting of the town. 3700 w. Engng—July 21, 1899. No. 28877 A.

Portable Plant.

A Portable Generating Plant (Wagon Porteur d'un Groupe Electrogène). Brief description of a car containing boiler, engine and electric generator, the whole adapted to be hauled to any point on the tracks of a railway system. 500 w. 1 plate. Génie Civil—Aug. 12, 1899. No. 29206 D.

Sparking.

Experiments Upon a Continuous Current Generator With Two Independent Windings (Versuche an einer Gleichstrommaschine mit zwei unabhängigen Wickelungen). A. Sengel. A discussion of experiments with independent windings and a third brush to avoid sparking in a continuous current dynamo. Two articles. 6000 w. Elektrotech Zeitschr—July 27, Aug. 3, 1899. No. 29270 each B.

St. Helens.

St. Helens Corporation Electricity Works and Tramways. Illustrated detailed account. 5300 w. Elec Rev, Lond—July 21, 1899. No. 28874 A.

Stockholm.

Stockholm Central Station. An illustrated account of a station belonging to the municipality, with table showing its progress. 1100 w. Elec Eng, Lond—Aug. 11, 1899. No. 29149 A.

West Ham.

West Ham Corporation Electric Supply Works. Illustrates and describes the plant. The system of supply is the single-phase alternate-current system, with transformer sub-stations. 2500 w. Elect'n, Lond—Aug. 4, 1899. No. 29-064 A.

HEATING AND WELDING.

Rail-Welding.

Electric Rail-Welding at Buffalo. Illustrates and describes a plant of the Lorain Steel Co. in operation in this city where 50 miles of track is being welded. 900 w. Elec Wld & Elec Engr—Aug. 12, 1899. No. 29019.

Warming by Electricity (Le Chauffage par l'Electricité). A. Bainville. A general review of the progress which has been made in warming by electricity, describing various forms of apparatus, and indicating the probable development. 1800 w. L'Electricien—July 15, 1899. No. 29266 B.

Warming.

Electric Heating in a Carmelite Hospice. Illustrates and describes an interesting installation receiving its power from the Canadian Niagara Power Co. 1100 w. Sci Am—Aug. 5, 1899. No. 28917.

LIGHTING.

Arc Lights.

Cost of Light from the Electric Arc. Alton D. Adams. An analysis of costs for enclosed and open arc lamps, with the prediction that the high tension, open arc, will soon be displaced by the enclosed arc from constant pressure mains. 1700 w. Munic Engng—Aug., 1899. No. 28895 C.

Efficiency.

The Proper Efficiency of Incandescent Lamps for Central Stations, Including a Description of the Nernst Lamp. E. E. Cary. Read before the Canadian Elec. Assn. A table of the efficiency and average life of lamps at various voltages is given and discussed, with consideration of some of the difficulties in the operation of the Nernst lamp. 3000 w. Can Engr—Aug., 1899. No. 29044.

Electricity vs. Gas.

Electric Lighting versus Gas. John Martin. Read before the Pacific Coast Elec. Trans. Assn. Considers the two methods of illumination with a view to determining the proper rates. 2400 w. Jour of Elec—July, 1899. No. 29040.

Enclosed Arc.

Long Burning Enclosed Arc Lamps. William A. Turbayue. From a paper read before the Canadian Elec. Assn. Traces the improvements which led to the development of the long burning lamp, which has a life of 150 hours or more, the economies and other advantages. 2000 w. Can Engr—Aug., 1899. No. 29043.

Illumination.

See Gas Engineering.

MEASUREMENT.

Alternating Currents.

A Simple and General Method of Obtaining the Mean Value of the Power of an Alternating Current. Samuel J. Barnett. Mathematical demonstration. Also reprint of previous paper in which several typographical errors appeared. 1800 w. Elec Wld—Aug. 26, 1899. No. 29315.

A Simple Device for Measuring the Frequency of an Alternating Current. Hubert V. Carpenter. Describes a method in which a stretched wire vibrates in synchronism with the current. 1800 w. Elec Wld & Elec Engr—Aug. 5, 1899. No. 28935.

Current Strength.

On the Determination of Current Strength in Three-Pointed Star Resistance Systems. A. E. Kennelly. Explains a manner of computing these current strengths, and of producing two-phase currents from a three-phase system and *vice versa*. 2000 w. Elec Wld—Aug. 19, 1899. No. 29090.

Galvanometer.

The Theory of the Tangent Galvanometer and its Modifications. J. Warren. Part first explains the instrument and the manner of determining the angle of maximum sensitiveness. 1200 w. Elec, Lond—Aug. 11, 1899. Serial. 2 parts. No. 29144 each A.

Polyphase Systems.

Measurement of Power in Polyphase Systems. Aug. J. Bowie, Jr. Considers the cases of unbalanced and balanced loads usually encountered in practice. 1500 w. Elec Wld—Aug. 19, 1899. No. 29091.

POWER APPLICATIONS.

Canal Traction.

Experiments Upon the Lamb and the Köttgen Systems of Electric Towing (Elektrische Schleppschiffahrtsversuche mit dem System Lamb und dem System Köttgen). G. Klingenberg. With a number of illustrations showing the practical applications of the two systems on the Finow Canal. 7000 w. Elektrotech Zeitschr—Aug. 3, 1899. No. 29272 B.

Crane.

Electric Traveling Crane of 35 Tons Capacity (Elektrisch Betriebener Laufkran von 35 t Tragkraft). Paul Uellner. An illustrated description with numerous details, of a powerful crane recently constructed by the *Compagnie Internationale* d'Electricité, of Liége. 2500 w. Zeitsch d Ver Deutscher Ing—July 15, 1899. No. 29243 D.

Electric Locomotives.

See Railway Affairs, Motive Power.

Electrical Protection.

Electrical Protection of Safes and Vaults. Clyde J. Coleman. Read before the Chicago Elec. Assn. Reviews various means for protection that are in use or have been suggested, and the considerations to be met in providing an effective system. 1800 w. Sci Am Sup—Aug. 19, 1899. No. 29089.

Hat Works.

Electricity in Hat Manufacture. Illustrates and describes an installation for furnishing heat, light and power for use in the manufacture of hats. 1800 w. W Elect'n—Aug. 12, 1899. No. 29046.

Machine Driving.

The Form and Speed of Electric Motors Direct Connected to Machines. Alton D. Adams. Considers the possibility of making the motor a symmetrical part of the driven machine, the relation of speed of motor to the work, etc. Ill. 1000 w. Eng News—Aug. 10, 1899. No. 29008.

Mine Power.

Electricity in the Mines at Cripple Creek. Thomas Tonge. With many illustrations showing the wide range of applications of electricity for power in mining operations, as experienced in the gold mines of Colorado. 3500 w. Engineering Magazine—Sept., 1899. No. 29295 B.

Pantagraph.

An Electric Pantagraph. F. Jarvis Patten. Illustrates and describes the device and its use. 1400 w. Elec Wld & Elec Engr—Aug. 12, 1899. No. 29018.

Electric Engraving Machine. F. Jarvis Patten. Illustrates and describes a valuable application of the pantagraph, which seems destined to make machine engraving in wood or metal a reliable process at great speed and small cost. 1600 w. Elec Wld—Aug. 26, 1899. No. 29316.

Plow.

An Electric Motor Plow (Ein Elektrischer Motorpflug). Dr. E. Müllendorx. A very complete description of a system using electric power to haul gang plows back and forth. Two articles. 6000 w. Glaser's Annalen—Aug. 1, 15, 1899. No. 29250 each D.

Pumps.

Electrically-Driven Centrifugal Pumps. Lewis A. Hicks. Read before the Pacific Coast Electric Transmission Assn. Describes experiments made by the Kern County Land Co., and methods of investigating centrifugal pumps. Ill. 5000 w. Jour of Elec—July, 1899. No. 29039.

Wagon Works.

Electrical Equipment in Fish Bros.' Wagon Factory. Illustrates and describes the equipment of an extensive factory in Racine, Wis. 1800 w. W Elect'n—Aug. 26, 1899. No. 29330.

Works Distribution.

See Electrical Engineering, Distribution.

TRANSMISSION.

Conductors.

Aluminum vs. Copper. Charles T. Child. A comparison of the relative values of the two metals for electrical uses, showing aluminum to be the cheaper metal of the two at the present prices. 1100 w. Elec Rev, N. Y.—Aug. 30, 1899. No. 29386.

Insulation.

The Use of Insulated Cables for Strong and Weak Currents (Isolirte Kabel für Stark und Schwachstrom und ihre Herstellung). G. Zapf. A paper before the Electrotechnic Society of Cologne, discussing cables for telephone and other electrical conductors. 5000 w. Elektrotech Zeitschr—Aug. 10, 1899. No. 29275 B.

Regulations.

Safety Regulations for Electric Currents of Medium Voltage (Sicherheitsvorschriften für Elektrische Mittelspannungs-Anlagen). A full reprint of the regulations formulated by the Society of German Elektrotechnicians. 6000 w. Elektrotech Zeitschr—Aug. 10, 1899. No. 29274 B.

MISCELLANY.

Accidents.

The Physiological Properties of Electricity (Propriétés Physiologiques de l'Electricité). Dr. F. Mally. With especial reference to accidents in connection with the industrial applications of electricity, and instructions as to the aid of the injured. Two articles. 5000 w. Génie Civil—July 29, Aug. 5, 1899. No. 29204 each D.

Tanning.

Electric Tanning. Concerning a process, devised by Dr. L. A. Groth, which he claims shortens the period to about one-fifth the previous time and affects a saving of about 30 per cent. 900 w. Ind & Ir—Aug. 4, 1899. No. 29068 A.

Volta Centenary.

The Volta Centenary. Giulio Martinez. Notes and illustration concerning the exposition at Como, which was destroyed by fire. 900 w. Elec Wld—Aug. 26, 1899. No. 29317.

Some Notes on the Electrical Machinery at the Como Exhibition. Kenelm Edgcumbe. 1500 w. Elec Rev, Lond—Aug. 18, 1899. Serial. 1st part. No. 29342 A.

GAS ENGINEERING

Acetylene.

A New Acetylene Generator. From *La Nature*. An illustrated description of a new apparatus called the "Bruncor." 700 w. Sci Am Sup—Aug. 26, 1899. No. 29183.

The Acetylene Exhibition and Congress at Budapest. An account of the meeting, with abstracts of important papers and comments. 3000 w. Engr, Lond—Aug. 11, 1899. No. 29168 A.

Ammonia.

The Utility of Sulphate of Ammonia in Agriculture. James Muir. Explains the manner of action of sulphate of ammonia, showing how it may best be used on the various crops of the farm with a view to profit. 6400 w. Jour Gas Lgt—July 18, 1899. Serial. 1st part. No. 28854 A.

Bye-Products.

Gas Purification with Recovery of Bye-Products. Dr. J. Bueb. Abstract translation of a paper read at a recent meeting of the German Assn. of Gas and Water Engs. A paper of much interest, with editorial. 5000 w. Jour Gas Lgt—Aug. 1, 1899. No. 29024 A.

Gas Purification, with Recovery of Bye-Products. The discussion on Dr. Bueb's paper. 2200 w. Jour Gas Lgt—Aug. 8, 1899. No. 29094 A.

Carbide.

The Cost of a Ton of Calcium Carbide for Different Sources of Power (Herstellungskosten von 1000 kg. Calcium Carbid bei Verschiedenen Betriebskraften). F. Liebetanz. A paper read before the Acetylene Congress at Budapest, showing the influence of the cost of power upon the cost of carbide. 3000 w. Zeitschr f Elektrochemie—Aug. 10, 1899. No. 29279 G.

See Also Electrical Engineering, Electro Chemistry.

Coke-Oven Gas.

See Mining and Metallurgy, Coal and Coke.

Electrolysis.

Electrolytic Trials. William A. Aldrich. Read before the Pacific Coast Gas Assn. An explanation of the action and its destroying effect on iron pipes, giving the troubles in various cities. Discussion. Ill. 7000 w. Am Gas Lgt Jour—Aug. 14, 1899. No. 29051.

Exhausters.

Gas Exhausters and Gas Exhausting Plant. R. Hargraves. Condensed paper read before the Manchester Assn.

of Engs. Shows that the most up-to-date plant for exhausting coal gas is behind good engineering practice of the present day. 2200 w. Gas Engs' Mag —Aug. 10, 1899. No. 29311 A.

Fuel Gas.

Fuel Gas. C. Francis Jenkins. On the change gas manufacture is undergoing, adapting it to wider uses. Ill. 1000 w. Sci Am—Aug. 12, 1899. No. 28996.

The Fuel Question in California. John L. Howard. Read before the Pacific Coast Gas Assn. Considers the causes that make this state draw a greater variety of coals from more sources than any other country; discusses the progress being made by gas fuel; the use of oil for steam generation; and of electricity from water power. Discussion. 6500 w. Am Gas Lgt Jour —Aug. 14, 1899. No. 29050.

Furnace Gas.

Blast-Furnace Gas for Motive Power. W. H. Booth. An account of experiments with the Thwaite apparatus, with suggestions for the treatment of American gas. 2500 w. Mod Mach—Aug., 1899. No. 28957.

The Actual State of the Question of Gas Engines Operated by Furnace Gas (Etat Actuel de la Question des Moteurs à Gaz de Haut-Fourneau). H. Savage. A review of the experiences which have been had in the use of furnace gases in motors in Belgium, Germany and Scotland, showing that the matter has passed the experimental stage. 4000 w. Rev Univ des Mines—July, 1899. No. 29227 G.

The Utilization of Blast Furnace Gases (Zur Ausnutzung der Hochofengase). F. Zeyringer. A discussion of the chemical and thermal questions involved in the production and utilization of furnace gases in internal combustion motors. 2000 w. Stahl und Eisen—July 15, 1899. No. 29258 D.

Utilizing Charcoal Blast-Furnace Gases. F. Zeyringer. Abstract of article in *Stahl und Eisen*. Enumerates the factors which determine the constitution and quantity of the waste gases, and describes a set of furnaces worked with charcoal fuel. 1200 w. Eng & Min Jour —Aug. 12, 1899. No. 29030.

Gas Calculations.

"27.68." Henry O'Connor. An explanation of the usefulness of these figures in various problems of gas engineering. 1200 w. Jour Gas Lgt—Aug. 15, 1899. No. 29174 A.

Gas Compressor.

Intensified Gas Lighting, With and Without Water Power. James Keith. Abstract of paper presented at Stirling meeting of the North British Assn. Describes Keith's automatic air and gas compressors and explains their advantages. Ill. 1500 w. Gas Wld—July 29, 1899. No. 28976 A.

Gas Power.

See Street and Electric Tramways.

Gas Works.

Notes on Building Construction in Small Gas Works. S. B. Langlands. Read before the North of Ireland Assn. of Gas Mgrs. Calls attention to points of construction and states the writer's views concerning the advantages of certain treatments. 2400 w. Gas Wld—Aug. 19, 1899 No. 29341 A.

Illumination.

Artificial Illumination for Ordinary Business and Domestic Purposes. Leon P. Lowe. Read at meeting of the Pacific Coast Gas Assn. A comparison of the illuminating power and cost of gas light, Welsbach light, electric incandescent, and acetylene gas. 2200 w. Am Gas Lgt Jour—Aug. 7, 1899. No. 28970.

Artificial Light, With Special Reference to Gas and Electricity. A. Yuill. Read at the Stirling meeting of the North British Assn. Reviews early methods of producing light, and the history of the gas industry, comparing gas and electricity. Discussion. 4500 w. Gas Wld—July 29, 1899. No. 28974 A.

Intensive Lighting. M. A. Lecomte. Summary of a paper read before the Société Technique du Gaz en France. On the means of producing intensive lighting; the burners, chimneys, mantles, etc. Ill. 5000 w. Gas Wld—Aug. 5, 1899. No. 29060 A.

Mantles.

On Incandescent Mantles; Effects of Various Oxides. W. Bruno. Translated and abstracted from the *Zeitschrift für Beleuchtungswesen*. Gives results of a long series of experiments in hardening the mantles, with discussion of the action of ceria. 2500 w. Gas Wld—Aug. 19, 1899 No. 29340 A.

Photometer.

An Improved Form of Portable Photometer. Illustrates and describes a simple and reliable instrument. 500 w. Eng News—Aug. 10, 1899. No. 29013.

Prices.

In Favor of Differential Prices for Gas. R. B. Anderson. Read before the North of Ireland Assn. of Gas Mgrs. Advocates the adoption of differential rates where the prices are high. Discussion. 7500 w. Gas Wld—Aug. 12, 1899. No. 29339 A.

Purification.

Further Observations on Purification. S. Carpenter. Suggestions relating to the purification of gas from sulphur. 2800 w. Jour Gas Lgt—July 25, 1899. No. 28910 A.

Rates.

Differential Rates as Between Consumers of Gas for Lighting and for Purposes other Than Lighting. A paper called out by the statements made by Thomas Newbigging. 2500 w. Jour Gas Lgt—Aug. 22, 1899. Serial. 1st part. No. 29391 A.

Retorts.

The Working of a Semi-Regenerative Setting. W. A. Reid. Describes work of the writer, and gives brief discussion. 1800 w. Jour Gas Lgt—Aug. 15, 1899. No. 29177 A.

Self-Ignition.

Self-Ignition, Far and Near. On the interesting installation recently made at the Waterloo Station of the South-Western Railway, England. 1300 w. Jour Gas Lgt—Aug. 1, 1899. No. 29-025 A.

The Automatic Ignition of Gas by Chemical Means. J. B. Grimwood. On igniters depending for action upon the property of certain metals to absorb gases. Discussion. 5000 w. Am Gas Lgt Jour—Aug. 21, 1899. No. 29143.

Testing.

On the Continuous Mode of Testing Gas. C. R. C. Tichborne. Read before the North of Ireland Assn. of Gas Managers. Describes in detail a process for estimating ammonia. 1600 w. Jour Gas Lgt—Aug. 15 ,1899. No. 29175 A.

Water Gas.

Carburetted Water Gas. Ivison Macadam. Lecture delivered at the Stirling meeting of the North British Assn. Describes the plant used and its working. Discussion. 3300 w. Gas Wld—July 29, 1899. No. 28975 A.

MARINE AND NAVAL ENGINEERING

Anti-Fouling.

The Dangers of the Use of Metallic Copper in Anti-Fouling Compositions. Reviews the various attempts made to protect the hulls of vessels, and the trouble with metal sheathing, explaining the need of demanding a guarantee that anti-fouling paint contains no metallic copper. 1600 w. Engs' Gaz—Aug., 1899. No. 29004 A.

Armament.

Rifled Naval Artillery. Andrew Noble. Abstract of a paper read at meeting of the Inst. of Naval Archts., England. Reviews progress since 1850 in the armament of battleships. 2700 w. Ind & Ir—July 21, 1899. No. 28876 A.

Battleship.

The New British Battleship "Vengeance." Description of a first-class battleship in process of construction. 2200 w. Engng—July 21, 1899. No. 28882 A.

Boilers.

On the Boiler Arrangement of Certain Recent Cruisers. F. T. Marshall. Comparison of systems used and description of arrangements adopted in recent vessels of the cruiser class. Ill. 5300 w. Engng—Aug. 11, 1899. No. 28889 A.

British Navy.

Ships Building for the British Navy. From *Black and White.* Illustration showing the great number of vessels in construction, with information relating to them. 1200 w. Sci Am Sup—Aug. 12, 1899. No. 28998.

Canal Boats.

Self-Propelling Steel Canal Boats. Waldon Fawcett. Describes these boats briefly, and gives information concerning a pontoon barge to be constructed for conveying these boats on the American Great Lakes from Cleveland to Buffalo and return. Ill. 1100 w. Sci Am—Aug. 26, 1899. No. 29178.

Cargo Handling.

Cargo Handling Machinery at Lake Erie Ports. Waldon Fawcett. Illustrates and describes the latest machinery for transferring coal and ore from vessel to car or from car to vessel. 4000 w. Am Mfr & Ir Wld—July 27, 1899. No. 28851.

Cargo Steamers.

Large Atlantic Cargo Steamers. G. B. Hunter. Read before the Institution of Naval Architects. Discusses some leading features of what the writer considers a typical American freight steamer of the present. Ill. 3000 w. Engng—Aug. 18, 1899. No. 29360 A.

Coal Consumption.

Coal Consumption in the British Navy. Editorial discussion of statements made and of Commodore Melville's arguments. 1800 w. Engr, Lond—Aug. 18, 1899. No. 29356 A.

Cruisers.

Faulty Features of Our Proposed Sheathed and Coppered Cruisers. Compares the proposed type with ships of a similar size and class among the navies of the world, with the conclusion that if built these vessels will be the least efficient of the seven compared. Also editorial. 2700 w. Sci Am—Aug. 19, 1899. No. 29088.

On Elswick Cruisers. Philip Watts. Read at meeting of the British Inst. of Naval Archts. Gives particulars of Elswick cruisers built during the last ten years. 3000 w. Engr, Lond—July 28, 1899. No. 28994 A.

Our First Large Cruisers. Detailed description, with illustration, of H. M. first-class cruisers "Blake" and "Blenheim." 3000 w. Engr, Lond—July 28, 1899. No. 28993 A.

Present and Proposed Cruisers of the United States Navy Compared. Gives illustrations of the new cruisers and the "New Orleans" comparing them and pointing out the advantage of one over the other. 1500 w. Sci Am—Sept. 2, 1899. No. 29388.

Docking.

Graphical Method of Finding the Pressure on Blocks Under a Ship Due to Overhang. H. S. Hele-Shaw. A letter with explanation of the graphic construction given. 1000 w. Engng—Aug. 4, 1899. No. 29071 A.

Dock Yards.

The Mechanical Appliances Employed in the Construction of the Keyham Dockyard Extension Works. Whately Eliot. Read before the Inst. of Mechanical Engs. Describes briefly, and illustrates, the machinery which is being employed in excavation, dealing with materials, building operations and work-shops. 3200 w. Engng—July 28, 1899. No. 28987 A.

Dry-Dock.

Floating Dry-Dock for the British Navy at Bermuda. Brief illustrated description of a dry dock capable of lifting a ship of 10,000 tons displacement. 400 w. Ry & Engng Rev—Aug. 5, 1899. No. 28963.

Naval Dry Dock at Boston. Illustrates and describes this large concrete structure, which is to cost $1,025,000. 2000 w. Marine Rev—Aug. 17, 1899. No. 29139.

The Supporting of Ships in Dry Docks. Francis Elgar. Read at Newcastle, before the Inst. of Naval Architects. Considers the distribution of pressure over the bottom of a ship in dry dock, and over the dock blocks, and to what extent it may become dangerously affected by conditions that sometimes arise in docking. Ill. 4500 w. Engng—July 28, 1899. No. 28986 A.

Ferryboat.

Propeller Feryboat Berkeley in Service in San Francisco Bay. Illustrated detailed description. 1100 w. Marine Engng—Aug., 1899. No. 28914 C.

Germany.

The Development of German Shipbuilding. Rudolph Haack. Herr Haack's second paper deals chiefly with the growth of the shipyards on the North Sea Coast, with many handsome illustrations. 3500 w. Engineering Magazine—Sept., 1899. No. 29292 B.

Gunboat.

The Boiler Trials of the "Sheldrake." An illustrated description of the new boilers and report of the trials, which gave very satisfactory results. 1200 w. Engr, Lond—Aug. 11, 1899. No. 29163 A.

Ice-Breakers.

Ice-Breakers. H. F. Swan. Read at meeting of the Inst. of Naval Archts. Gives particulars of two vessels of this class embodying the latest practice; the "Sampo," built for the Finnish Government, and the "Ermack," built for the Imperial Russian Government. 2300 w. Engr, Lond—July 21, 1899. No. 28887 A.

Launch.

On the Launch of a Battleship. H. R. Champness. A detailed description of the launching of a modern battleship and of the appliances used for the purpose. 6500 w. Engng—July 28, 1899. No. 28982 A.

Marine Engines.

Triple-Expansion Engines of H. M. SS. "Cheerful" and "Mermaid." Brief description and illustrations. 350 w. Engr, Lond—July 21, 1899. No. 28886 A.

Marine Growths.

Marine Growths—An Effective Argument for the Building of Dry Docks. H. Webster. Explains the causes which make necessary the docking and cleaning of ships, and the complications of the problem to be solved by the shipbuilder. 3000 w. Marine Engng—Aug., 1899. No. 28913 C.

Naval Engagement.

The Spanish-American War. On the encounter of the fleets at Santiago. Ill. 2000 w. Engng—July 21, 1899. No. 28878 A.

Naval Engineers.

The Engine-Room Staff. Editorial discussion of the position of engineers in the British navy, and the grievances of the engine-room artificers. 1800 w. Engng—July 21, 1899. No. 28880 A.

Propulsion.

The Mechanical Theory of Steamship Propulsion. Robert Mansel. Briefly reviews published mathematical theories. 1800 w. Engr, Lond—Aug. 18, 1899. No. 29354 A.

Riveters.

Portable Pneumatic Riveters in Shipbuilding. W. J. Babcock. Read before the Inst. of Naval Archts., at the London meeting. Description and photographs showing the methods used. 2800 w. Engng—July 21, 1899. No. 28884 A.

School Ships.

Life of Naval Cadets and Apprentices on the German School Ships. Part first gives illustrations and particulars of the drill in sail manœuvres. 900 w. Sci Am Sup—Aug. 12, 1899. Serial. 1st part. No. 28997.

Ship Building.

Building a Ship. Philip Hichborn, in Boston *Sunday Herald.* A summary of progress from the earliest times, with details of modern practice in the construction of both wooden and steel vessels. 5200 w. Marine Rev—Aug. 17, 1899. No. 29138.

The Equipment of Shipbuilding Sheds. Illustrates and describes improvements at the works of Messrs. Swan & Hunter, Wallsend, Newcastle-on-Tyne. 900 w. Engr, Lond—Aug. 4, 1899. No. 29074 A.

Sounding.

A Bathometer Operating With Crushing Cylinders (Sur un Bathymetre Fondé sur l'Emploi de Cylindres Crushers). MM. Charbonnier and Galy-Arché. A device for determining depths of sea by the crushing pressure of the water upon cylinders such as are employed in determining artillery pressures. 1500 w. Comptes Rendus—July 24, 1899. No. 29226 D.

Speed.

The Speeds of Battleships. Editorial discussion of the value of speed, urging that if it is gained at the sacrifice of guns and armour the advantage is doubtful. 1500 w. Engr, Lond—Aug. 11, 1899. No. 29159 A.

Stability.

The Stability of Steamships and Sailing Vessels Under Light Burden (Sur la Stabilité des Vapeurs et des Navires à Voiles à l'Etat Lèger). A discussion of the effect of the absence of cargo upon stability, and also the effect of the distribution of the load. Serial. 1st part. 2000 w. Revue Technique—Aug. 10, 1899. No. 29218 D.

Steamships.

Machinery of H. M. SS. "Proserpine" and "Psyche" as Illustrative of the Work Done at Keyham, Particularly with Reference to the Practical Training of Engineer Students. Read at Inst. of Mech. Engrs., England. An illustrated detailed description. 3000 w. Engng—Aug. 18, 1899. No. 29362 A.

Thrust-Blocks.

Experiments on Thrust-Block Friction. F. von Kodolitsch. Read before the British Inst. of Naval Architects. Describes and illustrates the construction of the thrust-block and gives an account of experiments carried out to ascertain what percentage of the indicated horse-power is lost by friction. 1000 w. Engng—July 28, 1899. No. 28985 A.

Torpedo Boats.

What a Torpedo Boat is Like. Lawrence Irwell. Describes these boats and their development, the scanty quarters, and their action. 1500 w. Marine Rev —Aug. 3, 1899. No. 28967.

Tow Boats.

Large Steam Tenders. Illustrates and describes a fleet of five vessels under construction for the Mississippi River Commission by the Iowa Iron Works of Dubuque, Iowa. 1700 w. Marine Rev—Aug. 3, 1899. No. 28968.

Triple Screws.

Admiral Melville's Reply. Reply of the Engineer-in-Chief of the United States Navy to criticisms from English engineers regarding his advocacy of the use of triple screws in vessels of war. 3000 w. Am Mfr & Ir Wld—July 27, 1899. No. 28852.

Water Tubes.

Some Experiments Having Reference to the Durability of Water-Tube Boilers. A. F. Yarrow. Read at meeting of the Inst. of Naval Archts., England. Results of experiments recently carried out to ascertain the comparative merits of nickel steel tubes and tubes of mild steel. Ill. 2500 w. Engr, Lond—July 21, 1899. No. 28888 A.

The "Parole" Water-Tube Boiler. An illustrated description of this type, with report of test. 1400 w. Engng—July 21, 1899. No. 28879 A.

See Marine and Naval Engineering.

Wrecking.

Loss and Subsequent Recovery of the American Line Steamship "Paris," An account of the recent disaster, with engraving, and report of Capt. Frederick Watkins. 1500 w. Marine Engng—Aug., 1899. No. 28916 C.

Yachts.

"Columbia" and "Shamrock"—A Comparison. Estimates made show when the speed is over 8 knots an hour, "Shamrock" shows a slight advantage over a windward and leeward course, and "Columbia" a superiority over a triangular course. Also editorial. Ill. 3000 w. Sci Am—Aug. 12, 1899. No. 28995.

Strengthening the "Shamrock" for the Atlantic Voyage. Describes the provision made for the ocean voyage of this cup challenger. 500 w. Engr, Lond—July 28, 1899. No. 28992 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Efficiency Trials.

The Agricultural Hall Exhibition Efficiency Trials. Gives complete results of these trials. 1600 w. Automotor—Aug., 1899. No. 29336 A.

Electromobiles.

The Electromobile Exhibition of the Automobile Club de France. Constantin de Kubicki. A detailed description of the prominent types lately exhibited in Paris. Ill. 1800 w. Elec Rev, N. Y.—Aug. 23, 1899. No. 29171.

The Monnard Electromobile. Translation of an article by M. Delaselle in *La Locomotion Automobile.* Description, with several illustrations. 1200 w. Automotor—Aug., 1899. No. 29334 A.

Fire Engine.

A New Automobile Fire Engine. From *La Nature.* Illustrates and describes a fire engine invented by M. Porteu, which has been found to operate most successfully. 500 w. Sci Am Sup—Aug. 5, 1899. No. 28918.

French Regulations.

Automobile Regulations in France. A review of the new French regulations governing the use and sale of self-propelled vehicles of every type. 2100 w. Eng Rec—Aug. 12, 1899. No. 29036.

Liquid Air.

See Mechanical Engineering, Miscellany.

Liverpool Trials.

The Liverpool Heavy Motor Vehicle Trials. A full account of the trials, with illustrated description of the vehicles. Also editorial. 11300 w. Automotor—Aug., 1899. No. 29333 A.

The Liverpool Motor-Wagon Trials. Brief account of the second annual series of trials of motor-vehicles for heavy traffic. Describes vehicles and tests. 1500 w. Transport—Aug. 4, 1899. No. 29059 A.

Motor.

The Bolide Motor and Mechanism. Illustrated description. 700 w. Automotor—Aug., 1899. No. 29335 A.

Paris Exhibition.

Automobile Exhibition at Paris. Editorial on the second exhibition of automobiles held under the auspices of the Automobile Club of France, calling attention to tendencies in the evolution. 2200 w. Engng—July 21, 1899. No. 28881 A.

The International Competition of Heavy Weights (Concours International des Poids Lourds). The official report of the commission upon the exhibits and trials at the competiton of the Automobile Club of France in Oct., 1898; with many illustrations. Three articles, 1 plate. 25000 w. Génie Civil—July 29, Aug. 5, 12, 1899. No. 29203 each D.

Phaetons.

Phaetons at the Exposition of the Automobile Club. The first of a series of articles discussing the vehicles exhibited at the recent exposition in Paris. 1200 w. Sci Am Sup—Aug. 26, 1899. No. 29181.

Steam Wagon.

The Crouch Steam Wagon. Hugh Dolnar. Illustrated description. 1700 w. Am Mach—Aug. 17, 1899. No. 29109.

The Dudgeon Steam Wagon. Hugh Dolnar. Illustrated detailed description. 1500 w. Am Mach—Aug. 2, 1899. No. 29192.

Steering.

The Steering of Automobiles With Divided Axles (Du Virage des Automobiles à Essieux Brisés). D. Dujon. An analysis of the action of independently adjustable steering wheels, showing the method adopted for the prevention of slippage on short turns. 1200 w. Revue Technique—Aug. 10, 1899. No. 29219 D.

Trials.

The Paris Cab Trials. Translated from *Le Génie Civil.* An account of the June trials, with description of the vehicles. Ill. 6400 w. Automotor—Aug., 1899. No. 29337 A.

HYDRAULICS.

Hydraulic Pressure.

Use of Hydraulic Pressure in Engine Erection. Illustrates and describes its use at the 96th street power house, New York. 700 w. Power—Aug., 1899. No. 28898.

Pumping Engine.

Quadruple Expansion Pumping Engine at the Wildwood Station, Pittsburg, Pa. Three views, with side and front elevations, detailed description, and report of test. 3000 w. Power—Sept., 1899. No. 29387.

See Mining and Metallurgy, Mining.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

An Apprenticeship System in College Shops. O. P. Hood. Read at the Columbus meeting of the Society for the Promotion of Engineering Education. Explains the opinions that led to a trial of an apprentice system, the results, and the writer's belief in its usefulness. 1600 w. Am Mach—Aug. 24, 1899. No. 29195.

Boring.

Boring Cranks with Hydraulic Feed. H. S. Brown. Illustrates and describes a device arranged by the writer, with remarks on its uses, and on improved tools. 1700 w. Am Mach—Aug. 24, 1899. No. 29196.

Castings.

Producing Straight Castings, and Methods of Straightening. R. D. Moore. Considers various methods, and the treatment in special cases. 1700 w. Am Mach—Aug. 10, 1899. No. 29021.

Crane.

See Electrical Engineering, Power Applications.

Crank Position.

Finding the Position of the Crank when the Position of the Piston or Cross-Head is Given. Michele Ferrero. Gives a solution of this problem. 500 w. Am Mach—Aug. 17, 1899. No. 29108.

Cupola.

Improvements in Melting Furnaces (Neuerungen in Schmelzöfen). E. Herz. Illustrating and describing an improved foundry cupola, with auxiliary tuyeres and heated blast, by which a high economy is attained. 1500 w. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1899. No. 29252 D.

External Pressure.

Computation of External Pressure on Rings and Tubes (Berechnung des Zulässigen Aussendruckes bei Ringen und Röhren). Dr. P. Forchheimer. Deriving mathematical formulæ, and showing the reinforcing effect which may be expected from stiffening rings. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 1899. No. 29241 B.

Forge Shop.

A Model Heating and Ventilating System and Down Draft Forge Shop. An illustrated description of the apparatus used and plan of installation in the West Side High School Building of Milwaukee, and the down draft method of removing smoke in the forge shop of the same school. 1100 w. Heat & Ven—Aug., 1899. No. 29167.

Forging Machine.

The Rice Forging Machine at the Pope Mfg. Company. An illustrated detailed description of the machine and its operation. 3800 w. Ir Age—Aug. 24, 1899. No. 29184.

Gearing.

Epicyclic Gearing. Illustrates and explains its principles of operation and its application in machine design. 2800 w. Mach, N. Y.—Aug., 1899. Serial. 1st part. No. 28858.

Gears.

Elliptic Gears. Illustrates cases where elliptical gear wheels are employed to advantage. 900 w. Prac Engr—Aug. 18, 1899. No. 29348 A.

Iron Mixtures.

Silicon Control of Carbon in Cast Iron. F. E. Bachman. A contribution to the discussion of the paper of B. S. Summers, read at the Buffalo meeting of the Am. Inst. of Min. Engs. Paper, omitting the tables, giving the writer's comments, which differ from the usual teaching concerning silicon. 1500 w. Ir Trd Rev—Aug. 3, 1899. No. 28928.

Labor-Saving.

Some Devices at the Meadows Shops of the Pennsylvania Railroad. Illustrates and describes some useful labor-saving devices in daily use at these shops. 900 w. R R Gaz—Aug. 25, 1899. No. 29198.

Machine Driving.

See Electrical Engineering, Power Applications.

Malleable Iron.

Malleable Cast Iron—Its History in the United States. George C. Davis. Reviews the practice in earlier times, the difficulties encountered, some of the earlier foundries, etc. Ill. 3800 w. Jour Fr Inst—Aug., 1899. Serial. 1st part. No. 28945 D.

The Basic Furnace for Malleable Iron. E. C. Wheeler. A discussion of facts relating to the malleable industry, and the possibilities of the basic furnace. 3800 w. Foundry—Aug., 1899. No. 29168.

Mechanical Works.

The Mechanical Works and Operations of Manchester and District. Gives illustrated description of the important works and their products. 10500 w. Ir & Coal Trds Rev—Aug. 11, 1899. No. 29352 A.

Melting.

Melting Iron for Foundry Purposes. Walter J. May. Some points on cupola and crucible furnaces and their management. 1100 w. Prac Engr—July 28, 1899. No. 28977 A.

Metal Work.

Metal Work. T. Swaffield Brown. Abstract of a paper read before the Sheffield Society of Architects. On the principles and processes, the materials used, etc. Ill. 4000 w. Can Archt—Aug., 1899. No. 29129 C.

Milan, Italy.

The Shops and Products of Brioschi Finzi & Co., Milan, Italy. Illustrated description of five shops, the chief products being electric generators and motors. 900 w. Am Mach—Aug. 17, 1899. No. 29107.

Molding.

Molding a Double Cylinder. Joseph Horner. Illustrated detailed description. 2000 w. Mech Wld—Aug. 4, 1899. Serial. 1st part. No. 29061 A.

Pump Governor.

Control of Pumps by Means of Dynamometric Indicator (Contrôle des Pompes au Moyen de l'Indicateur Dynamométrique). Emile Colmant. With numerous indicator diagrams showing how the fluctuations of pressure in the water cylinder may be used to govern the action. 4500 w. Rev Univ des Mines—July, 1899. No. 29228 G.

Repairs.

Boiler Patching. W. G. Ranton. Describes the two methods known as soft and hard patching. 1600 w. Power—Aug., 1899. No. 28899.

Riveters.

See Marine and Naval Engineering.

Shop Hints.

Some Shop Hints. Illustrates and describes some interesting tools and methods used in the shops of the Calumet Electric Street Ry. Co., Chicago. 1400 w. St Ry Rev—Aug. 15, 1899. No. 29112 C.

Small Tools.

Cutter Bars and Chucking Reamers. H. S. Brown. Illustrates and describes these tools which have been recently much improved. 1100 w. Am Mach—Aug. 17, 1899. No. 29110.

Stamping.

A Difficult Job of Stamping. E. E. Minard. Illustrates and describes the tools used and the method of making the stamping shown. 900 w. Am Mach—Aug. 10, 1899. No. 29023.

Strengthening Pipes.

Method of Strengthening Copper Steam Pipes Longitudinally. T. Messenger. Read before the Northeast Coast Inst. of Engs. & Shipbuilders, England. Illustrates and describes the system adopted by the writer. 500 w. Marine Engng—Aug., 1899. No. 28915 C.

Tools.

Machine Tools—Their Construction and Manipulation. W. H. Van Dervoort. Aims to bring out clearly the principal points of construction and methods of operation. Ill. 2500 w. Mach, N. Y.—Aug., 1899. Serial. 1st part. No. 28859.

Verification.

The Optical Verification of Lines and Surfaces (Vérificateurs Optiques des Lignes et Surfaces). Ch. Dévé. An elaborate discussion of the optical methods which may be employed in mechanical operations for verifying the accuracy of planes. A long and valuable paper. 1500 w. Bull de la Soc d'Encour—July, 1899. No. 29221 G.

Wages.

A Logical System of Wages. John Richards. Discusses the present methods of compensating labor, and suggests a co-operative contract system, illustrating by example. 3500 w. Am Mach—Aug. 24, 1899. No. 29194.

Systems for the Remuneration of Labor. P. J. Darlington. A critical examination of the claims of the Premium system, in comparison with the Piece Rate method, showing the deficiencies of the former system. 4500 w. Engineering Magazine—Sept., 1899. No. 29293 B.

Work Shop.

A "Fin-de-Siecle" Machine Shop. Fred. Bathurst. Describes and illustrates machines in a fine shop in Austria. 3000 w. Elec Rev, Lond—Aug. 18, 1899. Serial. 1st part. No. 29343 A.

MATERIALS OF CONSTRUCTION.

Association.

The Work of the International Association for Testing Materials. An address by Prof. Mansfield Merriman, chairman of the American section of the Assn., at the Pittsburg meeting. A review of the progress in ascertaining the properties of materials of construction, and establishing rules for testing. 3000 w. Eng News—Aug. 17, 1899. No. 29-099.

Bicycle Tubes.

Strength of Bicycle Tubes. Oberlin Smith. Reviews briefly seamless tube drawing and describes tests made, giving results of some 28 tests of pieces about 15 inches long. Ill. 1900 w. Jour Gas Lgt—Aug. 3, 1899. No. 28911 A.

Cast-Iron Tests.

Influence of the Length of Span in Transverse Tests of Cast-Iron. Dr. R. Moldenke. Describes a series of tests made and gives the averages of the results obtained. 1400 w. Eng News—Aug. 17, 1899. No. 29102.

The American Foundrymen's Association Tests on Cast Iron as Related to Electrical Machinery. R. Moldenke. Gives a brief outline of the plans and study of the work already completed in which designers and builders of electrical machinery will be interested. 2500 w. Elec Wld—Aug. 26, 1899. No. 29314.

Elasticity.

Experiments Upon the Difference in Elasticity of Chilled Iron and Ordinary Cast Iron (Untersuchungen über den Unterschied der Elastizität von Hartguss und von Gusseisen Gewöhnlicher Härte). C. Bach. Discussing particularly the behavior of irons of different hardnesses when used as the runway for ball-bearings under heavy pressure. 7500 w. Zeitschr d Ver Deutscher Ing—July 22, 1899. No. 29245 D.

Enameling.

Enameling as an Industry. Josef Vollkomuser, in *The Metal Worker*. Considers the materials used, their composition, the preparation of the metal, cost, etc. 2300 w. Dom Engng—Aug., 1899. No. 29133 C.

Expansion.

The Expansion of Iron and Steel at High Temperatures (Sur la Dilatation du Fer et des Aciers aux Températures Elevées). H. Le Chatelier. A communication to the French Academy showing the relation between the expansion and the molecular transformation of iron and steel. 1200 w. Comptes Rendus—Aug. 7, 1899. No. 29232 D.

Fractures.

Pig-iron Fractures and Their Value in Foundry Practice. J. W. Miller. On the unreliability of grading based on fracture and the value of chemical analysis. 3300 w. Ir & Coal Trds Rev—Aug. 18, 1899. No. 29369 A.

Impact Tests.

Impact Tests of Structural Steel. S. Bent Russell. Illustrates and describes tests made by a new method under which the specimens were broken by tensile stress, giving results. 4500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29-302 E.

Metallography.

The Mechanical Uses of the Science of Metallography. Albert Sauveur. A fully illustrated exposition of the method of studying the physical structure of metals by magnified etched sections showing the great practical value of the system in daily use. 4500 w. Engineering Magazine—Sept., 1899. No. 29297 B.

Mineral Wool.

The Manufacture of Sulphur-Free Mineral Wool. A. D. Elbers. Gives the history of the manufacture of this product, and the invention which makes it quite certain such an article can be produced. 2000 w. Eng & Min Jour—Aug. 26, 1899. No. 29329.

Nickel Steel.

Temporary and Residual Variations in Reversible Nickel-Steel Alloys (Sur les Variations Temporaires et Résiduelles des Aciers au Nickel Réversibles). C. E. Guillaume. A continuation of the experiments of the author upon nickel-steel alloys, with especial reference to the construction of standards 1500 w. Comptes Rendus—July 17, 1899. No. 29223 D.

Oil Testing.

Notes from the Oil Testing Department (Aus der Abtheilung für Oelprüfung). A number of brief notes by Dr. Holde, in charge of the department of testing lubricants at the Royal testing laboratory at Charlottenburg. Questions of viscosity, gravity and inflammability are discussed. 4000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part II., 1898. No. 29238G.

Steel Pipe.

Friction Coefficient for Riveted Steel Pipe. A. McL. Hawks. Informal discussion of what is the proper friction coefficient for use in the design of riveted steel pipe. 1600 w Pro Am Soc of Civ Engs—Aug., 1899. No. 29305 E.

Transformations.

The Changes of State of Iron and Steel (Sur les Changements d'Etat du Fer et de l'Acier). H. Le Chatelier. A communication to the French Academy giving the results of investigations into the phenomena of recalescence, and of magnetic and physical transformations. 1500 w. Comptes Rendus—July 31, 1899. No. 29231 D.

POWER AND TRANSMISSION.

Animal Energy.

The Development of Energy by a Man Raising and Lowering His Own Weight (Thermogénère et Depense Energétique chez l'Homme qui Elève ou Abaisse son Propre Poids). A. Chauveau. A very full account of the author's experiments upon animal energy, with measurements of the heat developed, and the work performed. 3500 w. Comptes Rendus—July 31, 1899. No. 29229 D.

Air Friction.

The Variable Coefficient in Formulas for Friction of Air—Determination of the Coefficient. J. E. Johnson, Jr. Discusses a possible origin of the variable coefficient. Supplementary to an article published July 27, which considered the constant coefficient only. 1700 w. Am Mach—Aug. 3, 1899. No. 29169.

Pneumatic Transmission.

The Transmission of Energy by a Partially Rarified Atmosphere. Frederick Bramwell, Sir Frederick Bramwell. Read at the Plymouth meeting of the Inst. of Mech. Engrs. Reviews the history of the development of this mode of transmission, and its application to railways, especially considering the South Devon Atmospheric Railway. 5500 w. Engr, Lond—Aug. 18. 1899. No. 29357 A.

Regulation.

The Regulation of Power Machinery (Das Reguliren von Kraftsmaschinen). J. Isaachsen. A general discussion of the fundamental principles of the regulation of motors, including steam and hydraulic machinery, in connection with a consideration of the inertia of the moving masses. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 5, 1899. No. 29247 D.

SPECIAL MOTORS.

Diesel Motor.

Diesel Motor in America. A brief account of Rudolph Diesel and his work, with illustrated description of the engine. 1200 w. Mod Mach—Aug., 1899. No. 28955.

Improvements in the Diesel Motor. States the principles of the method for effecting ignition and combustion in internal combustion motors. Ill. 1000 w. Automotor—Aug., 1899. No. 29338 A.

Furnace Gas.

See Gas Engineering.

Gas Engines.

A Few Uses for Cylinder Cooling-Water of Gas Engines. O. F. Allen, in *The Gas Engine.* Mentions a few means for saving the heat of cylinder-cooling water. 1500 w. Mech Wld—Aug. 4, 1899. No. 29062 A.

A 650-Horse Power Gas Engine. Illustrates and describes a large three-cylinder gas engine of the Westinghouse type. 800 w. Col Guard—Aug. 4, 1899 No. 29076 A.

Petroleum Motor.

Petroleum Motors, with Especial Reference to the New Motors of Diesel and of Dopp (Ueber Petroleum-Motoren mit besonderer Berücksichtigung der Neueren Motoren von Diesel und von Dopp). A paper before the German Society of Mechanical Engineers showing that the Dopp Motor gives results as economical as the Diesel. 6000 w. Glaser's Annalen—July 15, 1899. No. 29248 D.

The New Mors Vertical Petroleum-Spirit Motor. Illustrates and describes a new motor of the vertical twin-cylinder type, capable of working up to 8 h. p. 900 w. Ind & Ir—Aug. 4, 1899. No. 29069 A.

STEAM ENGINEERING.

Accidents.

Accidents to Steam Boilers (Accidents d'Appareils à Vapeur). The official report for France for 1897, with numerous illustrations and data concerning boiler explosions and other disasters to steam apparatus. 7000 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29215 E + F.

Blow-Offs.

Blow-Off Pipes. H. H. Kelley. Discusses the care necessary and often neglected, and the proper location of the blow-off pipe and construction of boiler settings. Ill. 2500 w. Engr, U. S. A.—Aug. 1, 1899. No. 28929.

Boiler Efficiency.

Mechanical Draft and Boiler Efficiency. Extracts from a paper by Walter B. Snow showing a saving in first cost and in operating expenses, and increased efficiency of the plant. 1400 w. Ir Trd Rev—Aug. 10, 1899. No. 29015.

Boilers.

Boilers With Steam Circulating Device (Chaudières avec Emulseur à Vapeur). An illustrated description of the boilers at the Cambria sugar refinery; being boilers of the elephant type with circulating pipes connecting the steam space to the heaters. 2000 w. 1 plate. Génie Civil—Aug. 5, 1899 No. 29205 D.

The Low Water Scapegoat. Editorial on the injustice of always attributing boiler explosions to low water. 700 w. Loc Engng—Sept., 1899. No. 29372 C.

See Marine and Naval Engineering.

Boiler Tubes.

See Railway Affairs, Motive Power.

Cleaning Boilers.

Method for Cleaning Boiler Tubes. Illustrates and explains the new method being introduced by the Union Boiler Tube Cleaner Co., of Pittsburg. 1200 w. Am Mfr & Ir Wld—Aug. 17, 1899. No. 29136.

Chimney.

A Ventilated Chimney Tower. Illustrated description of an aspirating chimney in a New York Hospital. 700 w. Eng Rec—Aug. 19, 1899. No. 29128.

Design and Computations for Steam Boiler Chimneys (Einheitliche Bestimmung über Anordnung und Abmessung von Schornsteinen für Dampfkesselanlagen). G. Lang. A very exhaustive treatment of the subject of masonry chimney design, discussing the subjects of proportions and constructive details for various conditions. Two articles. 10,000 w. Zeitschr d Ver Deutscher Ing—July 29, Aug. 5, 1899. No. 29246 each D.

Tests of Masonry for Chimney Construction (Prüfung von Schornstemmauerwerk). M. Gary. A report of tests made at the government testing laboratory at Charlottenburg, with many illustrations, diagrams and tables. 6000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part II., 1899. No. 29237 G.

Coal Consumption.

See Marine and Naval Engineering.

Coal Tests.

Comparative Tests of Bituminous Steam Coals. William H. Bryan and R. C. Carpenter. Discussion of paper by John W. Hill. 2500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29308 E.

Combustion.

Mechanical Draft. Henry B. Prather. Gives a review of the most important systems, and emphasizes the importance of giving proper attention to the firing of the boilers. 4500 w. Jour Assn of Engng Socs—July, 1899. No. 29379 C.

Exhaust Steam.

The Project to Warm Buildings from a Central Station in Providence, R. I. Abstract of a report by J. E. Denton on the relative economy of heating buildings by individual plants and by exhaust steam from a large power station. 3800 w. Eng Rec—Aug. 19, 1899. No. 29127.

Forced Draught.

A New Method of Forced Draught. Nelson Foley. Read before the Inst. of Naval Archts., at the Newcastle-on-Tyne meeting. Describes a system where the fire bars themselves are used as a means of forcing the air into the fire. Ill. 800 w. Engng—July 21, 1899. No. 28883 A.

Heat Losses.

Heat Losses in a Steam Boiler. W. F. Durand, in *The Boiler Maker.* Discusses the losses in the furnace, due to incomplete combustion, and the loss in the boiler. 3000 w. Ir Trd Rev—July 27, 1899. No. 28853.

Piping.

The Arrangement of Steam and Other Pipes, and Their Fittings. J. E. Edgcome. Read before the Munic. Elec Assn. Also discussion. Views concerning the arrangement especially in central stations of small or moderate size. Ill. 5000 w. Elect'n, Lond—July 21, 1899. No. 28871 A.

Pulverized Fuel.

Firing With Pulverized Coal (Kohlenstaubfeuerungen). A general review of the use of powdered coal, especially for boiler firing, both in connection with economy and smoke prevention. Various furnaces are described. Four articles. 4000 w. Schweizerische Bauzeitung—July 8, 15, 22, 29, 1899. No. 29263 each B.

Smoke.

Smoke Consumption and Economy of Fuel. Frank H. Mason. Describes the process of Mr. Paul Cornelius for the consumption of low-grade fuels, as exhibited in Berlin, Germany. 1800 w. Am Arch—July 29, 1899. No. 28855.

Smokeless and Smoke-Consuming Furnaces (Rauchlose und Rauch Verbrennende Feuerungen). W. Häntzschel. A discussion of the smoke problem with especial reference to the advantages of pulverized fuel; giving a description of the Wegener furnace. 3000 w. Gesundheits-Ingenieur—Aug. 15, 1899. No. 29256 B.

The Smoke Nuisance. Editorial on the attitude of the English people toward this question, the loss it represents, the need of educating public opinion, etc. 3000 w. Builder—Aug. 12, 1899. No. 29150 A.

Smokeless Firing.

See Railway Affairs, Motive Power.

Steam Engines.

A Forgotten Steam Engine. Editorial on an engine patented by Watt in 1769 which is claimed to be the most perfect steam engine, from the thermal efficiency point of view, it is possible to construct. 1800 w. Engr, Lond—Aug. 11, 1899. No. 29160 A.

High-Speed Engines. Illustrated abstract of paper by J. H. Dales before Inst. Civ. Engs. on new methods of adjusting clearance in bearings and governing double-acting engines for high speeds. 4000 w. Eng Rec—Aug. 12, 1899. No. 29037.

Rolling Mill Engines (Walzenzugmaschinen). Giving illustrated description of a cross-compound reversing engine, and of a Schmidt tandem compound engine for superheated steam, with diagrams showing the distribution of pressures on the crank pin. 1000 w. 1 plate. Stahl und Eisen—July 15, 1899. No. 29257 D.

Rolling-Mill Reversing Engines. Illustrated detailed description of engines built for the Keystone Axle Company, of Beaver Falls, Pa., giving dimensions. 500 w. Engng—Aug. 11, 1899. No. 29165 A.

See Marine and Naval Engineering.

Steam Turbine.

Parsons' Steam Turbine. An account of the work done by Mr. Parsons, in introducing the steam turbine, with some of the results. Ill. 3400 w. Engng—Aug. 18, 1899. Serial. 1st part. No. 29358 A.

Superheating.

Economy in the Use of Superheated Steam. R. S. Hale. A conservative examination of the economy to be anticipated from the use of superheated steam, showing the conditions under which it should be practically successful. 2500 w. Engineering Magazine—Sept., 1899. No. 29291 B.

Superheated Steam—Its Use and Advantages. Ernst Prochaska. Remarks on the results obtained by the use of highly superheated steam, with description of Hering's steam superheater, and report of trials. Ill. 1300 w. Am Mfr & Ir Wld—Aug. 3, 1899. No. 28927.

Thermal Efficiency.

Report on the Thermal Efficiency of Steam Engines. A discussion of the report presented by the committee appointed by the Institution of Civil Engs. 4000 w. Engr, Lond—Aug. 18, 1899. No. 29353 A.

Valves.

An Improved Allen Valve. Illustrations and description of improved Allen valve brought out by the Richmond Locomotive Works with indicator diagrams showing effect of the change. 700 w. Loc Engng—Sept., 1899. No. 29375 C.

Safety Valves. H. H. Kelley. The Danger of neglecting safety valves, and the principle involved in the safety-valve lever. 3000 w. Engr, U. S. A.—Aug. 15, 1899. No. 29113.

Safety Valves. Illustrates and describes various types. 2800 w. Am Elect'n—Aug., 1899. No. 28862.

The Andrews and Martin Balanced Slide Valves. Illustrates and describes a valve more especially intended for use on marine engines, stating its advantages. 1600 w. Engng—Aug. 11, 1899. No. 29166 A.

The Richmond Double-Ported Valves. Features of the valve and diagrams showing comparative results of its use, with description and arguments for its use as given by Mr. Mellin. 600 w. R R Gaz—Aug. 18, 1899. No. 29115.

Water Hammer.

Water Hammer in Steam Pipes (Chocs de l'Eau dans les Conduites de Vapeur). M. Walckenaer. A discussion of the causes of water hammer in steam pipes, with illustrations of ruptures due to this cause and suggestions as to their prevention. 5000 w. Ann des Ponts et Chaussées—1 Trimestre, 1899. No. 29-214 E + F.

Water Tubes.

Water Tube Boilers. Robert S. Ball. A statement of the advantages of this type for large mining plants. 1100 w. Col Guard—Aug. 11, 1899. No. 29152 A.

MISCELLANY.

Air Resistance.

Researches Upon the Resistance of the Air (Recherches sur la Resistance de l'Air). The papers of M. Le Dantec and M. Canovetti, giving data and results of their experiments. A valuable contribution to knowledge. 10,000 w. Bull de la Soc d'Encour—July, 1899. No. 29220 G.

Bicycles.

Cycle Construction and Design. Archibald Sharp. This first lecture deals with the construction and design of the frame of the present-day type. Ill. 4000 w. Jour Soc of Arts—Aug. 18, 1899. Serial. 1st part. No. 29331 A.

Compressors.

The Air Compressor. O. G. Smith. A statement of the features of the process of air compressing. 1300 w. Min Rept—Aug. 17, 1899. No. 29173.

Education.

Technical High Schools and Scientific Investigation (Die Technischen Hochschulen und die Wissenschaftliche Forschung). An address by Prof. Riedler at the Technical High School at Charlottenburg comparing the work of that institution with the German universities. 4000 w. Zeitschr d Ver Deutscher Ing—July 15, 1899. No. 29244 D.

Gun Pressure.

The Law of Pressures in Gun Barrels (Sur la Loi des Pressions dans les Bouches à Feu). E. Vallier. Giving formulas and tables for various weights of charges, projectiles and initial velocities. 1200 w. Comptes Rendus—July 31, 1899. No. 29230 D.

Liquid Air.

Liquid Air as Portable Power. Frank Richards. Suggesting how liquid air could be used in this manner. 1200 w. Am Mach—Aug. 3, 1899. No. 28912.

Liquid Air for Automobile or Portable Service. Frank Richards. Outlines a scheme for using liquid air for an autocar motor. 1200 w. Am Mach—Aug. 10, 1899. No. 29022.

Refrigeration.

Ice Manufacture on a New System. Illustrates and describes the Holden system of ice manufacture, which can produce ice at a cost of 50 cts a ton. 2200 w. Sci Am—Sept. 2, 1899. No. 29389.

Science and Engineering.

The Relation of Physics and Astronomy to the Development of the Mechanic Arts. Cleveland Abbe. An address to the Franklin Institute on the inauguration of a new branch entitled "The Section on Astronomy and Physics," showing the close relation of the sciences to the mechanic arts. 14000 w. Jour Fr Inst--Aug., 1899. No. 28944 D.

The Scientist and the Engineer. Editorial comment and several recent addresses showing the importance of a mutual understanding. 1500 w. Eng Rec—Aug. 12, 1899. No. 29032.

Thermophone.

An Instrument for Indicating Temperatures at a Distance. Illustrated detailed description of the instrument and its operation. 1500 w. Eng News—Aug. 17, 1899. No. 29106.

MINING AND METALLURGY

COAL AND COKE.

Bosnia.

Coal Mining in Bosnia (Mittheilungen über den Kohlenbergbau in Bosnien). F. Poech. A general review of mining conditions in Bosnia, with illustrations of the arrangements of machinery, and profiles and sections of the workings. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 29, 1899. No. 29283 B.

Coal Mining in Bosnia. F. Poech. From *Oesterrichische Zeitschrift für Berg-und-Huttenwesen.* Describes the quality of the coal, method of working, the deposits, and gives information of general interest. Ill. 2000 w. Col Guard —Aug. 4, 1899. No. 29078 A.

Coal Fields.

The Coal Fields of the Southern States of America. Reports the exceptional development in this area, extending from the Virginias through south-eastern Kentucky and Tennessee into north-west Georgia and Alabama. 1800 w. Col Guard—July 28, 1899. No. 28989 A.

Coal Tests.

See Mechanical Engineering, Steam Engineering.

Coke-Oven Gas.

The Everett Coke-Oven Gas Plant. Dr. F. Schniewind. Describes and illustrates the works, their location, transportation facilities, coal-handling plant, coke ovens, etc. 4400 w. Pro Age—Aug. 15, 1899. Serial. 1st part. No. 29083.

New Zealand.

Coal Mining in New Zealand. Harrison F. Bulman. Information concerning the deposits, working, and coal mines act. 2400 w. Col Guard—July 21, 1899. No. 28890 A.

Coal Mining in New Zealand. Harrison F. Bulman. Information concerning the deposits, quality of the coal and manner of working. Ill. 1500 w. Col Guard—Aug. 18, 1899. No. 29363 A.

Shipping.

Coal Shipping. George Johnson. Information relating to business methods, charges, etc., in England. 2800 w. Col Guard—July 21, 1899. No. 28891 A.

South Wales.

The Re-Survey of the South Wales Coalfield. From the Summary of Progress of the Geological Survey of the United Kingdom for 1898. 2800 w. Col Guard—Aug. 18, 1899. Serial. 1st part. No. 29367 A.

COPPER.

Metallurgy.

The Metallurgy of Copper. H. Van F. Furman. Describes its chemical and physical properties and the various methods of extracting the metal from the ore. 3300 w. Mines & Min—Aug., 1899. No. 28953 C.

Production.

The World's Copper Production in 1898. Table showing the production from 1894-1898 with comment on the growth, and the important position of the United States as a producer. 1000 w. Eng & Min Jour—Aug. 12, 1899. No. 29028.

GOLD AND SILVER.

Africa.

The Gold Mines of the Gold Coast, Africa. Abstract from London *Financial News*. Supplement. Brief review of the past history and future prospects of this promising field. 1500 w. Eng & Min Jour—Aug. 5, 1899. No. 28966.

Australia.

A Neglected Gold Field. Reginald H. L. Hobby. Information concerning the Dark River field, about 240 miles from Melbourne. 1100 w. Aust Min Stand—June 20, 1899. No. 28908 B.

The Berringa Gold Field (V.). William Bradford. An account of the auriferous features and mining efforts. Part first considers the birthday group. Ill. 3000 w. Aust Min Stand—July 6, 1899. Serial. 1st part. No. 29097 B.

Cyanide Mill.

A Description of the Arequa Cyanide Mill at Cripple Creek, Colorado. Arthur Lakes. Describes how the ore is treated, and the machinery used in sampling, roasting and leaching it. Ill. 3000 w. Mines & Min—Aug., 1899. No. 28948 C.

Idaho.

The Buffalo Hump Mining Camp, Idaho. Charles L. Whittle. Describes the region, the camp, the quartz vein found, and a few claims near. 2000 w. Eng & Min Jour—Aug. 19, 1899. No. 29131.

Ores.

Notes on Milling of Low Grade Gold Ores. Edward W. Dee. Results of the experience and observation of a Colorado mine manager. 4800 w. Mod Mach—Aug., 1899. Serial. 1st part. No. 28-956.

Panama Deposits.

Age and Origin of Certain Gold Deposits on the Isthmus of Panama. Oscar H. Hershey. Of interest because the veins are of recent origin as compared with most gold-bearing ledges. 2000 w. Am Geol—Aug., 1895. No. 28946 D.

Patio Process.

The Patio Process in Guanajuato, Mexico. Roberto Fernandez. An explanation of this process for the treatment of silver ores, and the class ot ores to which it is best adapted. 1700 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29053 D.

Placer Deposits.

Testing and Sampling Placer Deposits. Edmund B. Kirby. Abstract of a paper read before the Colorado Scientific Society. Outlines the evidence to be secured by tests, etc., and the methods used in test workings. 2000 w. Eng & Min Jour—July 29, 1899. No. 28857.

Precipitation.

Note on Gold Precipitation by Zinc Dust. George A. Packard. Describes the method as used at the Mercur mines in Utah. 800 w. Jour Chem & Met Soc of S Africa—June, 1899. No. 28973 E.

Production.

The World's Silver Production. Shows the production of 1898 to have been larger than any year since 1892 and gives information of interest. 900 w. Eng & Min Jour—Aug. 19, 1899. No. 29130.

Slimes.

Notes on Sampling, Analyzing, and Treating Slimes. L. Ehrmann. Gives plan and description of an automatic sampler devised by the author, and discusses precipitation of slimes by milk of lime. 3300 w. Jour Chem & Met Soc of S Africa—June, 1899. No. 28972 E.

Veins.

Extensions of Great Veins. Arthur Lakes. How to follow them and some points to be considered in locating a claim on them. Ill. 2500 w. Mines & Min—Aug., 1899. No. 28952 C.

Wyoming.

The Grand Encampment and Saratoga Mining Districts of Wyoming. Thomas Tonge. An account of the region, its prospects and development. 2000 w. Mines & Min—Aug., 1899. No. 28954 C.

Zambesia.

Ancient Ruins and Gold Mines in Zambesia. From an account sent by Dr. Karl Peters to the London *Times*. The article describes the very ancient remains found, and mentions the mountain of Fura, very rich in gold. 1400 w. Eng & Min Jour—Aug. 12, 1899. No. 29029.

IRON AND STEEL.

Algiers.

The Iron Mines of Rar-el-Maden (Die Eisenerzgrube von Rar-el-Maden). With illustrations of these extensive mines, near Oran, Algiers, showing the cableways, and methods of working. 1000 w. Stahl und Eisen—July 15, 1899. No. 29259 D.

Annealing.

Brittleness Produced in Soft Steel by Annealing. John Edward Stead. Read before the Iron and Steel Inst., at the Stockholm meeting. A study of this subject giving the results of careful investigation. Ill. 5800 w. Bridges—July, 1899. No. 28961 C.

Austria.

The Development of the Austrian Iron Industry During the Past 50 Years (Entwicklung der Oesterreichischen Eisenindustrie in den Letzten 50 Jahren). A review presented at the semi-centennial celebration of the Austrian Society of Engineers and Architects. 3000 w. Stahl und Eisen—July 15, 1899. No. 29260 D.

Barrow Steel Co.

The Works and Operations of the Barrow Hemetite Steel Company. Illustrated detailed description of the works, with brief historical account. 5500 w. Ir & Coal Trds Rev—Aug. 4, 1899. No. 29067 A.

Cast-Iron.

The Silicon-Control of Carbon in Cast-Iron. F. E. Bachman. A discussion of the paper of Mr. Summers on "Modern Cupola Practice, etc." Gives tabulated analyses of the pig-iron of the Buffalo furnace, made during three years, from ore-mixtures varying slightly; also analyses of other irons from different places. 5000 w. Trans Am Inst of Min Engrs—Oct., 1898. No. 29052 D.

Carbon Combustions.

Carbon Combustions in a Platinum Crucible. P. W. Shiner. Illustrates and describes an apparatus devised by the writer, using a platinum crucible, with a water-cooled stopper, in place of the porcelain or platinum tube; an ordinary blast-lamp and Bunsen burner in place of the combustion furnace; and air instead of oxygen. 1800 w. Am Mfr & Ir Wld—Aug. 17, 1899. Serial. 1st part. No. 29137.

Cuba.

The Iron Mines of Cuba. A report by Robert P. Porter. Shows past and present conditions and the effect of the recent military operations on this industry. 2200 w. Ir Age—Aug. 17, 1899. No. 29095.

Cupola.

See Mechanical Engineering, Foundries.

Furnace Gas.

See Gas Engineering.

India.

I. The Iron Industry in the Territory of His Highness the Nizam Shamsul Ulama Syed Ali Bilgrami. II. India as a Center for Steel Manufacture. R. H. Mahon. Two papers read before the British Iron and Steel Inst., and discussed together. The first deals with the kinds of ores found; and the second records facts relating to the possibility of manufacturing iron and steel at a profit in India. 4000 w. Col Guard—Aug. 18, 1899. No. 29365 A.

Iron Mixtures.

See Mechanical Engineering, Foundries.

Iron Ores.

Iron Ores of the Potsdam Formation in the Valley of Virginia. Charles Catlett. A description of the general nature of these ores, cost of mining, capacity of the deposits, methods, etc. 4000 w. Trans Am Inst of Min Engrs—Feb., 1899. No. 29054 D.

Use of Finely-Divided Iron Ore. J. Wiborgh. Read before the British Iron and Steel Inst. Considers the ways in which powdered iron ores obtained by concentration may be utilized. Ill. 3500 w. Col Guard—Aug. 18, 1899. No. 29364 A.

Italy.

A Study of the Iron District of Lombardy (Studie über die Eisenindustrie in der Lombardie). A very full review of the iron production in Northern Italy, with map, and details of operation and cost; the district produces about 30,000 tons per year. Two articles. 1 plate. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 5, 12, 1899. No. 29284 each B.

Magnetic Ores.

Investigation of Magnetic Iron Ores from Eastern Ontario. Frederick J. Pope. Considers some of the relations existing between the geological associations and elementary constituents of their iron-ore bodies. 11800 w. Trans Am Inst of Min Engrs—Oct., 1899. No. 29055 D.

Malleable Iron.

See Mechanical Engineering, Foundries.

Melting.

See Mechanical Engineering, Foundries.

Meteoric Iron.

Note on a New Meteoric Iron Found Near the Tombigbee River, in Choctaw and Sumter Counties, Alabama, U. S. A. Warren M. Foote. An outline of the history of these masses, so far as known. Plates. 1300 w. Am Jour of Sci—Aug., 1899. No. 28894 D.

Separators.

Some Forms of Magnetic Separators, and Their Application to Different Ores. H. C. McNeill. Read before the British Iron and Steel Inst. Illustrates and describes some of the principal magnetic concentration plants of Sweden. 6000 w. Col Guard—Aug. 18, 1899. No. 29368 A.

Steel.

The Relation Between the Structure of Steel and Its Thermal and Mechanical Treatment. Albert Sauveur. Read before the Iron and Steel Inst. of Great Britain. Considers the changes of structure brought about by heat treatment, the changes by work, and gives conclusions of interest. 4300 w. Eng News—Aug. 24, 1899. No. 29190.

MINING.

Accidents.

Accidents from Falls of Roof and Side. Statement issued by Sir Kenelm E. Digby, giving precautions recommended for general adoption. 1000 w. Col Guard—Aug. 11, 1899. No. 29155 A.

Coal-Cutting.

Coal-Cutting Machinery. Edward W. Parker. Discusses only those machines which have survived the test of practice, and have shown by actual use the success of applying mechanical methods to the mining of bituminous coal. 13500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29056 D.

Drill Holes.

Drift in Diamond-Drill Holes. H. M. Lane. On the amount of dependence that can be placed upon the apparent position of the end of the diamond-drill holes. 1900 w. Mines & Min—Aug., 1899. No. 28949 C.

Explosives.

The Government and Permitted Explosives in Coal Mines. Concerning the new order which repeals the two orders now in force in the United Kingdom, and embodies their contents with additions and alterations. This order takes effect Oct. 1, 1899. 1400 w. Ir & Coal Trds Rev—Aug. 4, 1899. No. 29066 A.

Firedamp.

Ignition of Firedamp and Coal Dust by Means of Electricity. A report of experiments made to ascertain the danger in using electric appliances in mines. 1500 w. Mines & Min—Aug., 1899. No. 28951 C.

Mine Power.

See Electrical Engineering, Power Applications.

Miners' Pensions.

Old-Age Pensions and Relief Societies for Miners. Extracts from a report of the Labor Department of the Board of Trade, London, giving particulars of schemes in operation for the relief of miners in various countries. 5200 w. Col Guard—Aug. 4, 1899. No. 29077 A.

Mining Plant.

See Electrical Engineering, Generating Stations.

Mining School.

The Camborue Mining School. Interesting information concerning this school and its work. Ill. 1400 w. Engr, Lond —Aug. 4, 1899. No. 29073 A.

Orifice.

Relation Between a Mine's Equivalent Orifice and the Theoretical Thin-Edged Orifice. M. S. Hanappe. From a communication to the Sociètè des Ingenienrs des Mines du Hainaut. Shows the extent of the error committed by identifying these two and gives conclusions reached from calculations and facts given. 2500 w. Col Guard—Aug. 18, 1899. No. 29366 A.

Pumping Engines.

New Underground Pumping Engines for Mines. B. Gerdau, in the *Zeitschrift des Vereines deutscher Ingenieure*. An account of several underground pumping engines recently supplied to deep mines in the Westphalian coalfield and elsewhere. 1400 w. Col Guard—Aug. 4, 1899. No. 29080 A.

Underground Compound Pumping Engine at the Ettes Mine, Hungary (Unterirdischer Compound-Wasserhaltungsmaschine am Ettesar Schachte). Stefan Steuer. A combination pump with Riedler pump valves, and Corliss steam gear for forcing water a height of 220 meters, as used in the Salgo-Tarjan mines in Hungary. 3000 w. 1 plate. Oesterr Zeitsch f Berg u Hüttenwesen—July 15, 1899. No. 29282 B.

Underground Pumping Engine at a Hungarian Colliery. Stefen Steuer. *Oesterr Zeit für Berg und Huttenwesen*. Illustrated description. 1500 w. Col Guard—July 21, 1899. No. 28892 A.

Safety Lamp.

Re-Lighting Marsaut Lamp Fed With Benzine. From a communication by M. Lafitte to the Société de L'Industrie Minérale. Vertical section and details, illustrating this lamp fitted with Seippel re-lighter and adapted for burning benzine. 2000 w. Col Guard—July 28, 1899. No. 28988 A.

Subsidence.

The Effect of Subsidence Due to Coal Workings Upon Bridges and Other Structures. Stanley Robert Kay. Read before the British Inst. of Civ. Engs. The conditions in England which necessitate the construction of expensive structures often where mines have been worked, or exist and the information necessary in designing works in such situations. Full paper and part of discussion. Ill. 7200 w. Col Guard—Aug. 4, 1899. Serial. 1st part. No. 29075 A.

Underground Fires.

The Application of Liquefied Carbonic Acid Gas to Underground Fires. George Spencer. Abstract of a paper in Transactions Federated Inst. of Min. Engs. Reports a successful application to a mine fire, and suggests its value in other emergencies. 850 w. Eng & Min Jour—Aug. 5, 1899. No. 28965.

Ventilation.

Determining the Velocity of Ventilating Air-Currents. P. Fuchs, in *Zeitschrift für Berg-Hutten-und Salinenwesen.* Describes the mode of calculation and illustrates a reliable instrument for carrying out these measurements. 1300 w. Col Guard—Aug. 11, 1899. No. 29153 A.

The Best Arrangement of Ventilators to Enable the Utilization of the Entire Shaft Section (Welche Einrichtung Gestatten bei Oberirdischer Aufstellung des Ventilators den Ganzen Querschnitt eines Förderschachtes zur Wetterführung zu Benutzen). H. Dehnke. With illustrations showing the arrangement of head works to offer the least obstruction to ventilation. 1500 w. 1 plate. Glückauf—July 29, 1899. No. 29281 B.

Winding.

Method for the Supersession of Winding in Shafts. E. Mähnest, in *Glückauf.* Gives a diagrammatic vertical section showing the arrangement, and states the advantages of the method. 1500 w. Col Guard—Aug. 4, 1899. No. 29079 A.

Winding. W. Galloway. A lecture before the South Wales Inst. of Engs. Considers a complete winding outfit for a vertical shaft. Ill. 9500 w. Can Min. Rev—July 31, 1899. Serial. 1st part. No. 28902 B.

MISCELLANY.

Alloys

The Alloys of Tin and Lead. Erwin S. Sperry. Results of investigations to determine what combination of these metals produces the strongest alloy for use as soft solder. 1500 w. Foundry—Aug., 1899. No. 29170.

Conglomerates.

Metal-Bearing Conglomerates. Information concerning these deposits which have been found in various places and worked with profit. 1500 w. Min & Sci Pr—July 29, 1899. No. 28919.

High Temperatures.

Later Experience With the Goldschmidt Process for the Production of High Temperatures (Neues über das Goldschmidtsche Verfahren zur Erzeugung Hoher Temperaturen). F. Wüst. Relating experiences with the use of aluminum for the production of high temperatures, giving examples of practical applications. 1800 w. Stahl und Eisen—July 15, 1899. No. 29261 D.

Method of Producing High Temperatures (Verfahren zur Erzeugung Hoher Temperaturen). Dr. H. Goldschmidt. A paper before the German Electrochemical Society giving the further results of the author's method of producing high temperatures by the use of aluminum. 2000 w. Zeitschr für Elektrochemie—July 20, 1899. No. 29276 G.

Kaolin.

The Mining and Preparation of Kaolin. T. C. Hopkins. Abstract of paper in "The Mineral Industry," Vol. VII. Describes methods of mining and washing. Ill. 1400 w. Eng & Min Jour —Aug. 26, 1899. No. 29327.

Lead and Zinc.

The Dubuque Lead and Zinc Mines. H. Foster Bain. Describes the geological position and mode of occurrence of the ores and gives an account of their peculiarities. 3200 w. Mines & Min—Aug., 1899. No. 28950 C.

Lime Rock.

Mining Lime Rock by Electrically-Operated Cableways in Open-Pit Mining at Rockland and Rockport, Maine. Frank B. Knight. Description of the quarries and hoisting plant and a comparison of the earlier and later built cableways, showing the reasons for the greater economy of the latter. Ill. 4000 w. Mines & Min—Aug., 1899. No. 28-947 C.

Manganese.

Manganese Mining in Brazil. Information concerning the deposits now being worked, and the manner of working. 1000 w. Eng & Min Jour—Aug. 19, 1899. No. 29132.

Marble Quarries.

Modern Working of the Old Euboean Marble Quarries. Illustrations with a summary of W. Brindley's account of the location and nature of the quarries, and reference to the traditions of the island. 1200 w. Stone—Aug., 1899. No. 29380 C.

Mica.

Mica Mining in Bengal, India. A. Mervyn Smith. Abstract of paper read before the Institution of Mining and Metallurgy, London. Describes the native mines and methods of mining, and the use made of the mineral. 1200 w. Eng & Min Jour—Aug. 26, 1899. No. 29328.

Oil.

Notes on the Oil-Yielding Formations of California. W. L. Watts. A portion of a report to be published by the State Mining Bureau. Information of the value, geological features, depth affected, etc. Ill. 4000 w. Min & Sci Pr—Aug. 5, 1899. Serial. 1st part. No. 29026.

Production.

United States Mineral and Metal Production in 1898. Statistics showing the production of the more important substances to be the greatest on record. 5400 w. Eng & Min Jour—July 29, 1899. No. 28856.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in June. Detailed list and classified summary of 220 accidents, with remarks. 3000 w. R R Gaz—Aug. 11, 1899. No. 29002.

Electricity vs. Steam.

Electricity versus Steam for Branch Railroad Lines. Informal discussion of what are the economic conditions under which electricity may be profitably substituted for steam, and the engineering requirements. 6000 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29306 E.

Fast Runs.

Fast Running by the Pennsylvania Railroad to Atlantic City. Particulars of three runs made by engine known as Class E-1, put in service this year. 500 w. R R Gaz—Aug. 11, 1899. No. 29000.

Fast Run on the London & North-Western. An account of a run made by a special train from London to Crewe and return. 700 w. R R Gaz—Aug. 11, 1899. No. 29003.

Train Service.

The Summer Train Services—British and French. Charles Rous-Marten. Review of improvements and progressive features of the various lines. 4000 w. Engr, Lond—July 28, 1899. No. 28990 A.

Train-Speeds.

The Remarkable Train-Speeds in France. Comment on the speeds attained in France as given in a recent article by Mr. Rous-Marten, and a discussion of their engines as compared with English engines. Ill. 1500 w. Transport—Aug. 11, 1899. No. 29146 A.

FINANCIAL.

Rates.

The Public, the Railroads, and Rate-Cutting. Editorial discussion of the address of Martin A. Knapp at the meeting of railroad commissioners in Denver, Colo. 1800 w. R R Gaz—Aug. 18, 1899. No. 29116.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Lame Maintenance of Air-Brakes. C. F. Sundberg. Giving particulars of how carelessly the air brakes are kept up. 750 w. Loc Engng—Aug., 1899. No. 29191 C.

Wrong Location of the Semaphore Air Gage. Harry A. Flynne. The right and wrong way of placing air-brake gages is illustrated and described. 1000 w. Loc Engng—Sept., 1899. No. 29374 C.

Boiler Tubes.

Locomotive Boiler Tubes. Francis J. Cole, in *The Boiler Maker.* Gives specifications and tests for locomotive boiler tubes, and the requirements of prominent railroads. 1500 w. Prac Engr—Aug. 11, 1899. No. 29332 A.

Coal Car.

Standard Coal Car, 80,000 Lbs. Capacity, Wabash Railroad. Illustrated detailed description of cars in use on this line. 500 w. R R Car Jour—Aug., 1899. No. 28999.

Electric Locomotives.

Applications of Electric Traction on the Paris-Lyons-Mediterranean Railway (Applications de la Traction Electrique sur le Reseau de la Compagnie Paris-Lyon-Mediterranée). With a number of illustrations of electric locomotives operated by storage batteries, charged from hydraulic power plants in the Alps. 2000 w. 1 plate. Génie Civil—July 22, 1899. No. 29201 D.

Freight Cars.

A Point in Freight Car Construction. William J. Knox. Calls attention to the lack of bracing in long cars of great height and width, and thinks many cars now in service are deficient in this particular. Ill. 600 w. Loc Engng—Aug., 1899. No. 28865 C.

Furniture Car.

B. & O. Southwestern New 50-Ft. Furniture Car and Freight Car Truck. General dimensions and illustrated description. 1200 w. R R Gaz—Aug. 11, 1899. No. 29001.

Locomotives.

A Locomotive Boiler With Corrugated Furnace. Sectional views showing the construction of a locomotive running in freight service on the New York Central. 600 w. Eng News—Aug. 24, 1899. No. 29189.

American Locomotives on British Railways. Charles Rous-Marten. Mr. Rous-Marten's third paper contains the expressions of views and opinions of a number of eminent English authorities upon the design and performance of engines built in England and America. 3000 w. Engineering Magazine—Sept., 1899. No. 29296 B.

A Ten-Wheel Express Locomotive in England. J. P. P. Illustration with dimensions and an account of the line over which the engine runs, with facts of interest. 600 w. R R Gaz—Aug. 18, 1899. No. 29114.

Consolidation Locomotives. Gives illustration and chief dimensions of the engines for the Santa Fe Pacific Ry. 400 w. Am Eng & R R Jour—Sept., 1899. No. 29383 C.

Consolidation Locomotives for the Delaware and Hudosn Canal Co. Illustration and general dimensions. 500 w. Ry & Engng Rev—Aug. 5. 1899. No. 28964.

Heavy Ten-Wheel Freight Locomotives for the Union Pacific. Illustrations and dimensions of engines of more than ordinary interest because of their great size. 700 w. R R Gaz—Aug. 25, 1899. No. 29197.

Heavy Ten-Wheel Passenger Locomotive—Denver & Rio Grande Railway. Engraving, half-sectional front end view, general dimensions and particulars. 600 w. Ry & Engng Rev—July 29, 1899. No. 28901.

Heavy Ten-Wheel Passenger Locomotives. Illustration and general dimensions of heavy engines for the New York Central. 400 w. Am Eng & R R Jour—Aug., 1899. No. 28864 C.

Instructions of the Eastern Railroad of France as to Compound Locomotives. Abstract of directions given in the July Bulletin of the International Railroad Congress for the management of compound locomotives. 600 w. R R Gaz—Aug. 4, 1899. No. 28938.

Leverage of the Locomotive Driving Wheel. Illustrated and reasoned out by means of diagrams. 1800 w. Loc Engng—Sept.. 1899. No. 29373 C.

Locomotive for Swedish State Railways. Illustration and general dimensions of twenty six-wheel connected side-tank locomotives built at the Richmond Locomotive and Machine Works. 350 w. Ry & Engng Rev—Aug. 5, 1899. No. 28962.

New Passenger Locomotives of the Pittsburg and Western Railway. Illustration and principal dimensions. 450 w. R R Gaz—Aug. 4, 1899. No. 28937.

Pooling of Locomotives. Jas. S. Martin. Advantages and disadvantages are discussed. 700 W. Loc Engng—Sept., 1899. No. 29370 C.

Six-Coupled Express Engines for Northeastern Railway. Charles Rous-Marten Explains the problem that led to the trial of this new type of locomotive, and describes various runs. Ill. 2500 w. Engr, Lond—July 21, 1899. No. 28885 A.

Six-Coupled Locomotive, Cauca Railway, United States of Colombia. Illustrations, principal dimensions and specifications, with particulars. 700 w. Ry & Engng Rev—Aug. 12, 1899. No. 29081.

Ten-Wheel Freight Locomotive, Union Pacific Railway. Illustration and general specifications. 600 w. Ry & Engng Rev—Aug. 12, 1899. No. 29-082.

The Weight of Locomotive Engines. Editorial on the factors that determine the weight. 1500 w. Engr, Lond—Aug. 11, 1899. No. 29161 A.

Tire Wear of Locomotives. Thomas P. Whelan. Describes causes of uneven wear. 2000 w. Loc Engng—Sept., 1899. No. 29371 C.

Two Improvements in Compound Locomotives. Illustrates and describes the improvement in the Allen valve and in by-pass valves for low-pressure cylinders. 1700 w. Am Eng & R R Jour—Sept., 1899. No. 29384 C.

Wide Firebox Consolidation Locomotives. Illustration and chief dimensions of locomotives for the Delaware & Hudson Co., for burning anthracite coal. 700 w. Am Eng & R R Jour—Aug., 1899. No. 28863 C.

Smokeless Firing.

Smokeless Firing With Bituminous Coal on Passenger Trains. W. J. Murphy. Gives a copy of the instructions for firing passenger locomotives on the Queen & Crescent to prevent smoke. Ill. 1100 w. Loc Engng—Aug., 1899. No. 28867 C.

Steel Car.

Special Steel Car for Transporting Heavy Loads; North Belgian Railway. Illustrated detailed description of a special car of interest as showing French methods in car construction. 1100 w. Eng News—Aug. 17, 1899. No. 29100.

Valves.

The Intercepting Valve of the Schenectady Compound. C. R. Petrie. Describes this valve and explains its use and operation. 2200 w. Loc Engng—Aug., 1899. No. 28866 C.

NEW PROJECTS.

Arctic Railway.

The Making of an Arctic Railway. Abstract of an article in a recent number of *Aftonbladet.* Interesting details of the railway in course of construction from Gellivara to Victoriahavn in Norway. 1200 w. Ir & Coal Trds Rev—July 21, 1899. No. 28875 A.

Asia.

The Railways of Asia (Les Chemins de Fer de l'Asie). A general description of the present railway systems of Asia, and a discussion of lines projected and under construction. 3500 w. 1 plate. Rev Gen de Chem de Fer—July, 1899. No. 29236 F.

Ecuador.

The Proposed Guayaquil & Quito Railway in Ecuador. Illustrates and describes some of the principal features of this road. 1100 w. Eng News—Aug. 17, 1899. No. 29098.

England.

The London and North-Western's New Route to Buxton and Manchester. Describes a trip over the new line, the country through which the line passes, and some of the features. Ill. 1800 w. Transport—Aug. 4, 1899. No. 29058 A.

Euphrates Valley.

The Euphrates Valley Railway. Editorial review of the various projects during the last sixty years for constructing a line of railway in this valley, and showing the importance from a trade point of view, and as a connection between England and India. 1500 w. Engr, Lond—Aug. 18, 1899. No. 29355 A.

India.

The Railways of India. Information from the Administration Report for the year ending March 31, 1899. 3000 w. Ind & East Engr—July, 1899. No. 29142 D.

Nicaragua.

The Masaya-Diriamba Railway of Nicaragua. Illustrated description of a recently constructed branch railway from Masaya to Diriamba, which opens one of the most picturesque parts of this country. 1200 w. Eng News—Aug. 10, 1899. No. 29005.

Siberian.

The Western Lines of the Siberian Railway (Die Westlinie der Sibirischen Eisenbahn). A review of the progress and operation of the Siberian railway from Tscheljabinsk to Irkutsk, with a good map showing the entire Trans-Siberian system, and data as to cost. Two articles. 1 plate. 6000 w. Glaser's Annalen—Aug. 1, 15, 1899. No. 29249 each D.

The Trans-Siberian Railroad. Henry Michelsen. An illustrated abstract and the full article without illustrations. 4500 w. Sci Am & Sc Am Sup—Aug. 26, 1899. No. 29180.

The Trans-Siberian Railway. William Durban. A general survey of this line and its excellent construction, with remarks on its future possibilities and the effect it is to have on Siberia and the world in general. 5800 w. Contemporary Rev—Aug., 1899. No. 29085 D.

Uganda.

The Uganda Railway. An account of the line and the progress made, which has been very slow because of the great difficulties. Maps. 2500 w. Engng—Aug. 11, 1899. No. 29164 A.

PERMANENT WAY AND BUILDINGS.

Displacement.

Two Unusual Instances of Railway Track Displaced by Ocean Waves. Illustrates a case on the Nantucket Branch of the New York, New Haven and Hartford, and one on the Old Colony R. R. 450 w. Eng News—Aug. 24, 1899. No. 29185.

Railway Development.

Railway Development Still Continues. Editorial showing that the demand for railway material in the United States is in no danger of becoming of small importance. The mere replacement requires a large production; the building of side tracks, second tracks, etc., and improvements in roads all make large demands. 1600 w. Ir Age—Aug. 17, 1899. No. 29096.

Roundhouses.

Types of Russian Roundhouses. Illustrations of different types of engine-houses reproduced from the *Aperçu des Chemins de Fer Russes,* with brief description. 300 w. Ry Age—Aug. 11, 1899. No. 29049.

Station.

Coal, Ash and Sand-Handling Station—Illinois Central Railway, 27th Street Shops, Chicago. Illustrates and describes a station that has been in successful operation since January 1, serving about 100 locomotives a day. 1000 w. Ry & Engng Rev. July 29, 1899. No. 28900.

Ties.

Portable Plant for the Preservative Treatment of Railway Ties. Illustrates and describes a plant that may be hauled to any desired point and set up on temporary side tracks. 1400 w. Eng News—Aug. 17, 1899. No. 29105.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Discussion of paper by Walter W. Curtis. 7500 w. Pro Am Soc of Civ Engs—Aug., 1899. No. 29309 E.

Track in Tunnels.

Comparative Advantages of Ballasted Cross Ties and Unballasted Longitudinals for Railway Track in Tunnels. Jules Michel, in *Revue Generale des Chemins de Fer.* Abstract translation of this article which discusses the comparative advantages and cost. 900 w. Eng News—Aug. 10, 1899. No. 29006.

Washout.

The High-Water Damage to the Melk Section of the State Railways in 1897 (Die Hochwasserschäden des Jahres, 1897, im Bezirke der k. k. Bahnerhaltungs-Section Melk). R. Ziffer. A description of the nature of a number of washouts on the Austrian Railways and an account of the repair work. Two plates. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1899. No. 29251 D.

Water Stations.

Russian Water Stations. Illustrated description of the various sources of supply and the construction of water stations. Translated from the "Apercu des Chemins de Fer Russes." 1300 w. Ry Age—Aug. 18, 1899. No. 29141.

TRAFFIC.

Africa.

Statistics of the Railways of Algeria and Tunis (Statistique des Chemins de Fer Algériens et Tunisiens). The official report of the operations of the French railways in Northern Africa. 2000 w. Rev Gen de Chem de Fer—July, 1899. No. 29235 F.

Freight Methods.

Reforms in Freight Methods. J. W. Midgley. Notes some reforms which have been made and others which should be brought about. 2000 w. Ry Age—Aug. 11, 1899. No. 29048.

Mineral Traffic.

Railway Traffic During 1898. Statistics of traffic on roads of Great Britain, with special reference to the transportation of minerals. 2000 w. Col Guard—Aug. 11, 1899. No. 29154 A.

STREET AND ELECTRIC TRAMWAYS

Blackpool, Eng.

The Trolley Problem at Blackpool. An account of how the trolley has supplanted a conduit system, with illustrated description of the road. 1300 w. Elect'n, Lond—July 28, 1899. No. 28978 A.

Brake.

Brake System for Electric Cars and Trains (Bremsung Elektrisch Betriebener Wagen und Züge). Max Schiemann. A paper before the Berlin Electrotechnical Society describing an improved form of magnetic brake acting at the same time upon the rails and the wheels. 6000 w. Elektrotech Zeitschr—July 27, 1899. No. 29271 B.

Dudley and Stourbridge.

The Dudley and Stourbridge Electric Tramways. An illustrated account of a reconstructed line formerly a steam tramway. 2800 w. Elec Rev, Lond—July 28, 1899. No. 28981 A.

Düsseldorf.

High Speed Electric Railway Between Düsseldorf and Krefeld. An illustrated account of this road in Germany, the first installation of a high-speed electric railway in Europe. 2400 w. St Ry Jour—Aug., 1899. No. 28906 D.

Electrolysis.

Electrolysis at Kansas City, Kan. Illustrated statement of investigations by L. I. Blake showing internal as well as external corrosion of water pipes. 4200 w. Eng Rec—Aug. 12, 1899. No. 29034.

Extensions.

Extensions of the Lake Street Elevated Railroad. An account of some important extensions in Chicago. Ill. 800 w. W Elect'n—Aug. 12, 1899. No. 29045.

Florence, Italy.

The Electric Tramways of Florence. Illustrates and describes the present system and gives numerous views along the lines. 1700 w. Ry Wld—Aug. 10, 1899 No. 29350 A.

Gas Power.

Gas Tram Cars. Illustrates and describes these cars and the recent improvements made. 800 w. Engr, Lond—July 28, 1899. No. 28991 A.

Glasgow.

Glasgow Tramway Results. A report of the interesting and gratifying financial results of this very successful municipal undertaking. 1200 w. Engng—Aug. 4. 1899. No. 29070 A.

Hull, Eng.

Hull Corporation Electric Tramways Illustrates and describes the transformation being effected in the tramway facilities. 8000 w. Ry Wld—Aug. 10. 1899. No. 29349 A.

Hull Corporation Electric Tramways. Historical notes with illustrated description of the line and power station. 3600 w. Elect'n, Lond—July 28. 1899. No. 28979 A.

Light Railways.

A New Tramway Monopoly. Robert Donald. A discussion of the Light Railways Act of 1896, and the way in which it has miscarried. 2400 w. Contemporary Rev—Aug., 1899. No. 29084 D.

London Traction.

The London County Council and Electric Traction. Full text of the report of A. B. W. Kennedy to the Committee on mechanical traction on tramways. 4500 w. Elect'n, Lond—Aug. 18, 1899. No. 29347 A.

Maine.

A Model American Electric Railway System. Illustrates and describes the Lewiston, Brunswick and Bath Street Railway in the state of Maine. 2500 w. Engng—Aug. 18, 1899. No. 29359 A.

Multiple Unit.

The Multiple-Unit System of Electric Railways. Frank J. Sprague. Describes the system, and its illustration in the South Side Elevated Railway of Chicago. Discussion and appendix. Ill. Full paper. 31500 w. Trans Am Inst of Elec Engs—May, 1899. No. 29057 D.

Paris.

The Application of Mechanical Traction to the Lines from the Louvre to Vincennes (Application de la Traction Mecanique aux Lignes du Louvre à Vincennes). A. Monmerqué. A description of the accumulator electric traction system now being installed on an important section of the Paris tramways. 6000 w. Rev Gen de Chem de Fer —July, 1899. No. 29233 F.

Pittsburg.

Some Electrical Features of the Power Station of the Consolidated Traction Company of Pittsburg. Details of interest in regard to station equipment are described, a number of them differing from standard practice. Ill. 900 w. St Ry Jour—Aug., 1899. No. 28904 D.

Popp System.

Popp Compressed Air Motors for Tramway Traction. Illustrated description of this system, with a statement of its advantages. 2000 w. Compressed Air—Aug., 1899. No. 28893.

Quebec, Canada.

The Electric Railway Systems of Quebec, Canada. Illustrated detailed description of the route, the difficulties, service, equipment, construction, etc. 4000 w. St Ry Jour—Aug., 1899. No. 28903 D.

Receipts.

Comparative Gross Receipts of American Street Railway Companies. A table of comparative gross receipts of 222 American street railway companies for financial years ending in 1897 and 1898. 2000 w. St Ry Jour—Aug., 1899. No. 28905 D.

Richmond, Va.

The Richmond Traction Co., Richmond, Va. Illustrates and describes the single trolley system used and the equipment of the road, management, etc. 2800 w. St Ry Rev—Aug. 15, 1899. No. 29111 C.

Surface Contact.

The "Diatto" Surface-Contact System on Tramways at Tours. Illustrated detailed description. 2000 w. Ry Wld—Aug. 10, 1899. No. 29351 A.

Westphalia.

The Markisch Tramway System (Die Märkische Strassenbahn). Max Schiemann. An illustrated description of a suburban overhead-trolley line connecting a number of towns in the Arnsberg district of Westphalia; with details of the operation. 3000 w. Elektrotechnische Zeitschr—July 20, 1899. No. 29268 B

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STANDARDISING IN ENGINEERING CONSTRUCTION.

By Sir Benjamin C. Browne.

II.—THE ADVANTAGES OF SPECIALISATION IN DESIGN, MANUFACTURE, AND SALE OF PRODUCTS.

"A COMMON smith, who, though accustomed to handle the hammer, has never been used to make nails, if, upon some particular occasion, he is obliged to attempt it, will scarce, I am assured, be able to make above two or three hundred nails in a day, and " those, too, very bad ones. A smith, who has been accustomed to make nails, " but whose sole or principal business has not been that of a nailer, can seldom, " with his utmost diligence, make more than eight hundred or a thousand " nails in a day. I have seen several boys, under twenty years of age, who " had never exercised any other trade but that of making nails, and who, " when they exerted themselves, could make, each of them, upwards of two " thousand three hundred nails in a day. (Smith's Wealth of Nations)."

The above extract taken from a book published in 1776, and held to be a standard work ever since, sufficiently explains the importance of repetition, and of standardising our products as much as possible. It is often said that repetition work lowers the workman, makes his work purely mechanical and less interesting, and, therefore, makes him less intellectual; but we believe this view has no foundation in fact, as far more grasp of intellect is required to organise an economical system of standard reproduction, to carry it on, and to meet any irregularity or other defect in the system that may arise, than is required to do an isolated piece of good work, and the former certainly requires far more quickness and more sustained attention than the latter.

Sir Benjamin Browne's third and concluding article on this topic, in the December issue of THE ENGINEERING MAGAZINE, will deal with the influence which modern methods of intensified production are likely to exert upon the workman. It is a question which many

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A man who turns out a single piece of first class work may nevertheless dawdle and waste his time over it; but a man who has to work as part of a system, or to keep a number of machines going at high pressure, can neither dawdle nor get slovenly. He must keep his wits about him the whole time, and it is probable that not only will the day pass more quickly with him, but he is gradually qualifying himself to become a leader of men, in a way that is not open to the solitary workman, however skilful he may be. It is, in fact, to a great extent, a question of intellectual ability *versus* manual skill, and we would again call the reader's attention to the fact that standard work almost always is first class work of its kind and requirement. If a hundred pins are to be fitted indiscriminately into a hundred holes, it can only be by their being true, and exactly the right size, and, the more complicated the piece of work, the more perfect each part has to be to make that interchangeability which is the very essence of standardisation.

We will now approach this subject from the point of view of the man who intends to start new works—that is, from the viewpoint of the would-be capitalist, and would-be employer of labour.

Strange though it may appear, it is probable that few men, when they begin to form a business or lay down a works, ask themselves exactly what size of business they propose to undertake. They seem so afraid of cutting off any possible source of profit that, though they may have a central idea, the boundaries of their business are hardly fixed at all, or are marked out in their own minds in so vague and so undecided a manner that they vary them on the slightest pressure or impulse. This very commonly brings to them a large volume of unprofitable work, which swallows up the profits on their first-class business. It also injures their prestige, by inducing them to take up work with which they are not thoroughly familiar, and to put out designs which have not been thought out so fully and so carefully as they ought to have been.

Of course, there is a constant anxiety to please possible customers; but it seems to be the experience of most firms that work very closely to standards and object to making alterations, that complaints and criticisms almost always come from prospective purchasers, and that those who have actually bought their products are more thoroughly satisfied with them than they would be with those of a maker who

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approach with apprehension. Sir Benjamin is an apostle of hope; his paper will point clearly and confidently to the advantage which labour, as well as capital, is sure to reap in the new era of concentration and specialisation. THE EDITORS.

tried to please everybody's inexperience and pre-conceived theories. I will take the liberty of again quoting from "Chordal's Letters," as an illustration of my point, the following description of the way in which a careful American takes up the manufacture of a specialty:

"As an example of New England operations, let me cite one case: A steam engine of entirely new type was devised. It was taken to a celebrated concern. It was approved, and taken in hand. An engineer skilled in the science of steam and mechanics re-designed it. An engineer skilled in manufacturing joined hands and heads with the steam man, and the result was a machine which looked all right to the steam man, and which the factory man said he could make well, and cheap, and profitably. Then a few were made as any single article would be made.

" In the west these few engines would have been sold and some money brought in. But not so in this case. These engines were put to work, surrounded by skilled tests. They confirmed the judgment of the parties who were 'looking into it.' Did they go to work and sell them then? No, sir. They then began the tests for durability. Hour after hour, and month after month, every hour that there was steam in the factory boilers, did these engines whirl away at their heaviest loads, under every possible change in work and handling, and under the closest of scrutiny. They are running yet, and will be running next Christmas. When this test is over, will these factory people commence to make this engine for sale? I doubt it. I do not think they will ever 'make' these engines. When the tests are over, the system of manufacture, already in view, will be elaborated, and then a fortune will be expended in appliances; and then, and not till then, will the public be asked to buy. The engines will be manufactured, not 'made'; and that 'manufactured' means a well studied and economical production which is to the benefit of all concerned. All this, of course, in case this engine proves 'durable.' It may be disappointing, in which case the whole thing will go into the scrap pile; and the cost will be charged to expense, and will be a small loss to a concern which has accumulated millions of dollars by a continued demand for articles treated in the same careful, cautious, pains-taking manner.

" These heavy investments, based on a hope of future return are not an inventor's worship of his idol. This engine came from afar. These are capitalists looking up investments."

Now, probably, to perfect any product in this way is rather the mission of an old capitalist than of a young man starting first in business; but the process of thought ought to be the same in both cases, and anyone beginning a business ought to satisfy himself that there is some opening or sphere in the world, however small, which he must succeed in filling, to the advantage of society at large, somewhat better than it is filled at present; and he ought to realise that, after all, only a fractional part of his fellow creatures can ever be his customers, and he must not be unduly afraid of losing a few of those, who would do business with him if he were somewhat different.

Supposing a man decides that he can make a certain lathe, steam hammer, or other tool, that will cover a recognised want—say it is either a size larger, or a size smaller, than is generally used, or that it performs some recognised process more quickly and cheaply, or with less trouble to the operator, than the appliances ordinarily in use. Of course, his difficulty is that, though he may make something very perfect, he must also succeed in selling it; and to sell it, he must be able to bring it sufficiently easily before the public. Now here we come to a point, which is not nearly sufficiently recognised in manufacturing—that a manufacturer must have three entirely different qualifications or buy them from someone else, who will then become, to that extent, his servant or partner.

First of all, as described in the extract we have given, the machines, or whatever he means to sell, must be thought out and designed to be as perfect as possible. This requires a wide range of information, good scientific training, and ability. It is, in fact, the most perfect development of the work of the draughtsman, and probably one of the most important things to impress on the young manufacturer—or, for the matter of that, on all young engineers—is, that whatever they sell ought to be the best possible article for the purpose for which it is intended; not necessarily the best possible article in itself, because an article may be too costly for its special purpose. If it is only to be used rarely, or for a short time, it is no use spending money to give it a finish, or a durability, which would be very properly applied to work of a more permanent character.

For example, on public works, cranes, roads, and other things are put up which will very likely be swept away, or thrown on the scrap heap, at the end of a year or two. Now, a man might find it his business in life to make cranes of a transitory character for public works; and, if so, to make them quickly and cheaply and so as to be easy of erection, which would be more important than to make them thoroughly durable.

We see, in our extract from "Chordal's Letters," that the manufacturer apparently employed an outside engineer skilled in the science of steam and mechanics, to re-design his engine—or, possibly, two engineers in combination. This is one way over a difficulty, and manufacturers probably would be much wiser, if, whenever they want anything that is not exactly in their own range of experience, they would go, far more often than they do, to some other engineer, who has made a specialty of what is wanted, and pay him for his advice. It is probably the case that comparatively few engineering manufacturers, when (for example), they start a foundry, go to some outside man, who has made a specialty of foundry work, to design it for them; and yet on the way in which a foundry is laid out will probably depend entirely the question of whether it is a source of profit or los to the owner.

The second point on which a manufacturer wants to be qualified is, as a manufacturer—that is to say, as a manager of works. Having got his drawings made, the question then is to manufacture his article in the cheapest, quickest, and most efficient manner.

The third point is, of course, the work of bringing his manufactured articles before his customers, and selling them; and also the work of buying; we will not discuss these at present, however, but will dwell on the second point.

It is quite clear that this involves a wholly different class of experience from that required for the first qualification, and, while the need of high theoretical knowledge and training is less obvious, the need of long years of actual workshop experience is more obvious. In fact, we may say that for the draughtsman, science probably comes first, and experience second; with the workshop manager, experience first and science second. Nothing but long years of experience will really enable a man to get the very best results out of his tools and out of his men, or to select the most suitable man for each particular part of the work. For this reason, the making of standard articles is an especially suitable ladder by which the working man may climb into the position of a capitalist.

In the last paper, a description was given of the work of a subcontractor, or middle man, supposed to be a Yankee, and we are told by "Chordal" how he makes his way into a workshop to the benefit of all concerned. Now, what this Yankee contractor did may be done equally well by a small employer who has time to look thoroughly into his own business; but it is very important that the man who manages the shop, whether owner or official, should have power to try reasonable experiments and to make reasonable alterations, at his own discretion, without having at every step to obtain permission from and explain his policy to some higher power.

Of course, this power is all very well in the hands of a man of ability and integrity; but many men are never qualified to use it, and often men in such a position, if they are spending somebody else's money, lose their heads and get into all kinds of extravagance. As, however, the sub-contractor is so rare in England, we must hope to see his place supplied by the employer himself. That costs may be frequently reduced 20, 30, and 50 per cent. is within the knowledge of every practical man. In fact, the A. B. C. of engineering manufacturing is the enormous economy that is made by repetition, and the great margin for reducing the price and increasing the quality of work by high class appliances. It ought, of course, to be obvious to everybody that no manufacturer can expect to make money unless he has both the knowledge and the capital to enable him at once to adopt the best and cheapest possible means of doing each atom of his work; and, practically, to revert to the position of the man who is going into business, this must not be taken to mean always that he ought to have more capital—very often it means that he ought to have smaller works. In other words, given a man with a certain amount of capital, how is he to utilise it to the best advantage to himself? Suppose a man has £6,000. He would probably start works to employ about forty men, and should sell, each year, about £9,000 worth of finished machinery. These figures will vary very much according to the branch of trade in which he is engaged, but those stated are probably a fair average, and will answer our purpose. He then ought to review in his mind the possible class of work and number of articles that he will have to dispose of, and he must ask himself very seriously whether he can afford to put up the very best appliances, to enable this work to be turned out as cheaply as possible.

Taking men, boys, and labourers, all round, his wages bill will come to about 30 shillings per week per man, or say £3,000 a year; so every saving of 2 per cent. on his labour is equal to an increase of dividend of 1 per cent. on his capital. I have purposely made no allusion to borrowing powers. A man who can spend £6,000 on his works could certainly borrow, say, £3,000 more, but he will probably do better to keep that power in reserve, either to meet some unforeseen calamity, or to enable him to take advantage of some very exceptional opening that might arise afterwards.

Before our capitalist organises his works, he ought to take great pains to see as many as possible of other people's works, of a similar character, and also some of those of a somewhat different character which he understands to be specially well organised. It may be taken for granted that an employer, or a manager, who does not care to know what other people are doing, is certainly not in the way to make money. One of the best manufacturers that England ever saw used constantly to say that scheming was all very well, but what was really important and difficult was to find out what other people were doing. An employer on a large scale should never hesitate, if he has a chance, to buy up any man, whether opponent or otherwise, who understands some branch of his business better than he does himself. Few people, who think the question out quietly, will deny that business success is a constant struggle between a man's vanity and his thirst for knowledge; and it is surprising how common it is for a man to be kept among the unsuccessful all his life, simply because his vanity would not allow him to say to himself that he has been wrong, that somebody else knows better than he does, that he must change his system, and copy some other man if he wishes to succeed.

We all know how "Ready Money Mortiboy" told the village children that if they wanted to get on they must be discontented. This advice very much shocked the clergyman, and requires to be taken with some modification; but it had, from the manufacturer's point of view, one very strong element of truth, viz:—that no one ever ought to be satisfied with the results he is attaining; that whatever the cost of his work was last year, he ought to be dissatisfied if, under similar conditions, it is not somewhat less this year; and, as we have already seen that, roughly speaking, a man pays away every year in wages an amount something like equal to half his capital, it is obvious that if he can diminish the cost of his labour 2 per cent., or make his men and machinery turn out 2 per cent. more work in the same time and at the same cost, he is adding 1 per cent. to the dividend that he can pay on his capital. The question of paying 2½ per cent. dividend, more or less, may make all the difference whether a works shall be looked upon as successful or unsuccessful, and yet this great result may be simply a question of adopting labour-saving appliances so as to increase the output 5 per cent. without increasing the expense.

Most of us remember the great economy that came in when we took to stamping all sorts of small smith work under a steam hammer. Some people thought the days of blacksmiths were numbered, and that we should soon want none of them, but they have not become extinct, nor fewer, nor are their wages lower.

The same applies to other trades, wherever labour-saving appliances have been introduced. It is the same story; the cheapening of the selling price of the article has so increased the demand that the relative economy in labour is far more than covered by the absolute increase in consumption.

It may be thought that standardising is crystallising, and so stopping all progress; but this is not so—indeed, it cannot be. If a manufacturer were so wedded to his present standard that he refused to improve it, as time went on he would simply find himself superseded by other manufacturers. The needs of the world and the growth of invention set the pace of progress in these matters, and the question of standardisation only lies within these limits.

For instance, no one standardises more than a hatter. He turns out ready-made hats by the thousand, and yet the fashions in hats may alter every year. But the point is this: if he makes a large number exactly alike, the cost of the appliances for making them is spread over a larger number, or, in other words, the larger number he can make before the pattern has to be changed, the more costly and elaborate appliances he can afford to use in manufacture.

The changes will come at the same intervals of time, whether he manufactures many or few; and, supposing he has to remodel his plant once a year, the object is to make the greatest possible number out of the plant every year. So, in engineering, the requirements of the world and the skill of inventors will force periodical revisions of type, but the profit is made in making as many repeats as possible before the change comes. In short, suppose the letters of the alphabet represent twenty-six manufacturers, and there are twenty-six types of lathe, donkey engine, boiler mountings, or anything else, to be made; it would be ideally better for A only to have the plant for making one type, and get all the orders for that type and size. B would have the plant for another type and size, C for a third, and so on.

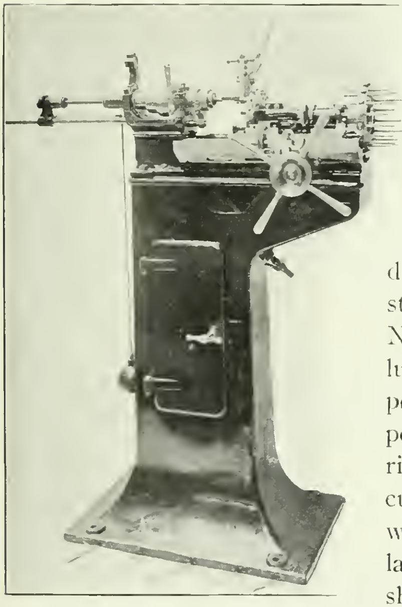
Of course, this is a counsel of perfection, but it is the ideal to be kept in mind; and above all, let every manufacturer remember that, to be successful, he must supply an article exactly suitable to the needs of the public. and manufacture such article in the cheapest and most accurate manner possible.

In a further paper, this question will be looked at from the point of view of the working classes, and the way in which their interests are affected.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

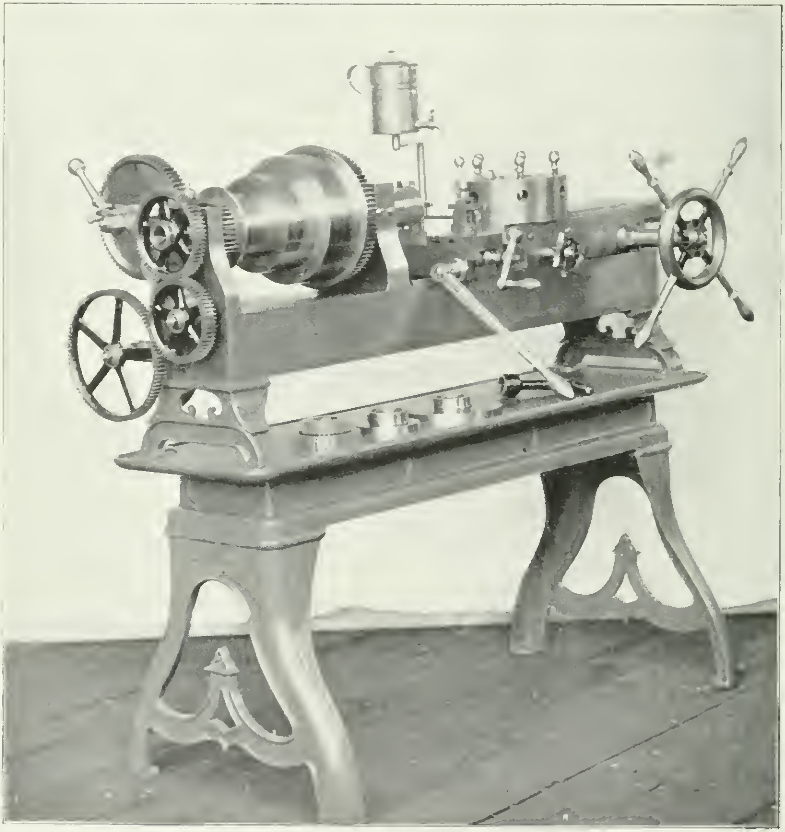
II.—THE DEVELOPMENT OF THE AUTOMATIC SCREW MACHINE.



A GERMAN REPETITION LATHE.

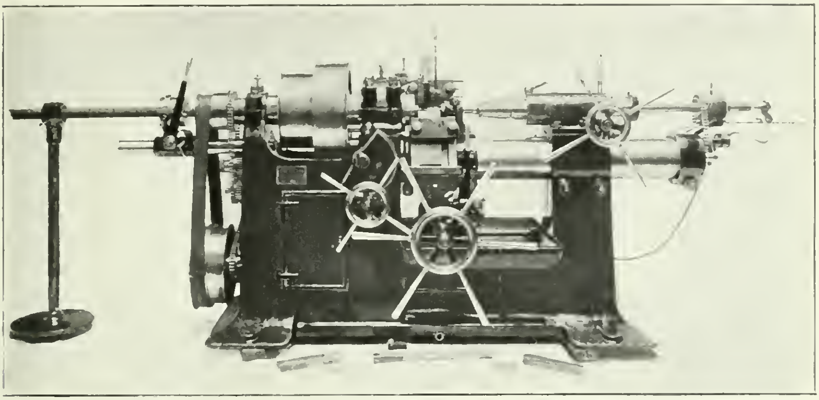
THE slide rest, as first brought out by Maudslay, was a sliding piece of metal, moved by a screw, and so secured to its support that, while it was capable of being moved freely in one direction, it was rigidly confined in all other directions, within the machine-construction sense of the word "rigid." No mechanical structure is absolutely rigid, and no cutting tool supported on a slide rest is rigidly supported so as to be moved in exactly a right line of travel, and no metal-cutting machine produces surfaces which are geometrically flat, circular, or spherical; but in a machine-shop sense, and for all practical purposes of ordinary machine use, good lathes produce round work and good planers produce flat work. Where a close approach to accuracy is needful, the imperfect work of the lathe and planer must be bettered by hand scraping, by lapping, and by grinding. Scraping is purely a hand operation, tested constantly in course of production by the use of hand-applied plane surfaces called "surface plates," which have close approximations to geometrically plane surfaces. Internal lapping, flat lapping, and cylindrical and conical grinding are all mechanical operations, and neither scraping, lapping, nor grinding is considered in these articles, which relate solely to the savings in labor cost of mechanical forms of metal which are made possible by the use of Maudslay's slide rest; this slide rest being fitted to carry a single cutting tool, rigidly secured to one of its exposed surfaces, which was the extent of its powers as developed by the early English toolmakers, or being fitted with turrets, as devised by American toolmakers in 1856 or 1857.

Generally speaking, Maudslay's slide rest, as applied to machine tools, carried but one single metal-cutting edge, and hence could form only one single finished surface on the work without a change in the form, position, or direction of motion of the cutting edge. These cutting edges, when used in the ordinary lathe and planer, are called simply "tools," each special form of "tool" having its particular name, as "diamond point," "side tool," "parting tool," "boring tool," and so on in great variety. All tools of this simple character are commonly forged on bodies of the same rectangular shape—that of the bar of



A TURRET LATHE FOR GENERAL USE.

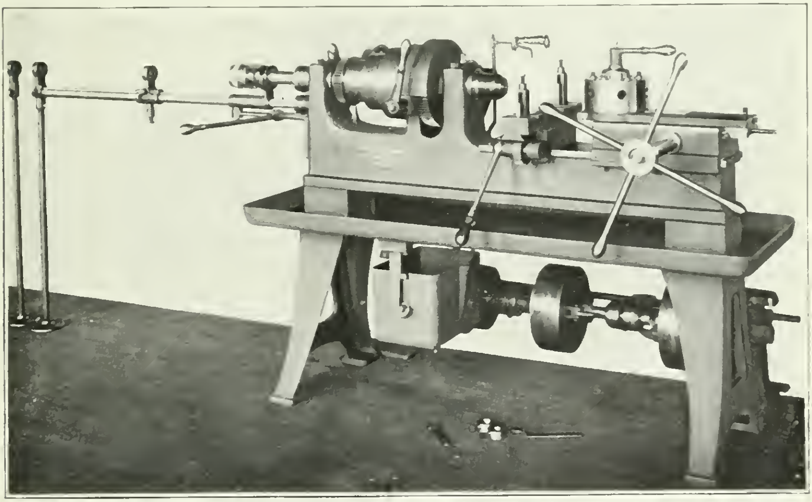
Made by Jones & Lamson about 1881.



GERMAN FORMING LATHE FITTED FOR MAKING BICYCLE HUBS.

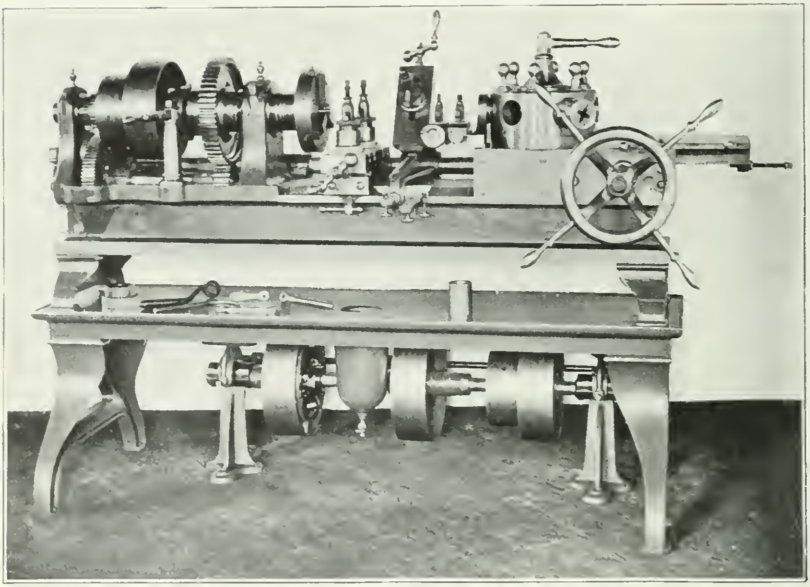
The machine weighs about 4 tons, and admits a 3-inch bar. Its peculiar feature is the massive cylindrical bed around which the tool-holder oscillates. As shown above, four tools are in operation—a borer, one broad-roughing, one finishing, and one parting tool. It will turn out an ordinary cycle hub from the rough bar in about 2½ minutes. Made by Pittler, of Leipzig.

tool steel from which they are produced by the tool-smith, who forges and tempers them—and are ground and set in place in the "tool-post" forming a part of the slide-rest slide by the mechanic who attends the machine tools in which these simple cutting tools are used. The shape of the cutting edge and its position in relation to the moving surface



REVOLVING-TURRET SCREW MACHINE.

Wire feed and turnstile feed to slide. Diameter of hole in spindle, 1$\frac{7}{16}$ in. Mills a length of 6¼ in. Made by Warner & Swasey.



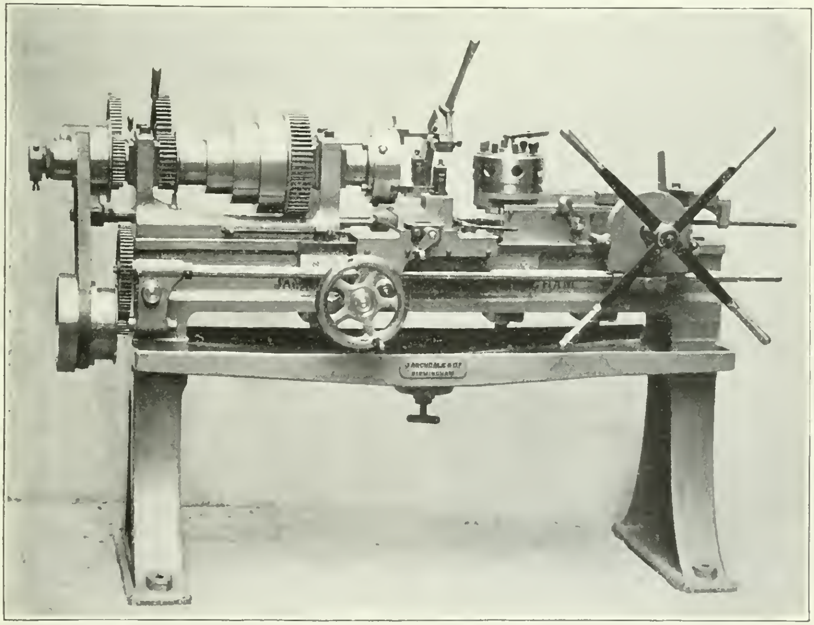
BRASS-WORKER'S TURRET LATHE OF ABOUT 1881.

Made by Jones & Lamson.

to be cut are determined by the workman, and the work is produced by a succession of roughing and finishing cuts passed over the surface in process of construction.

Maudslay's first slide rests were actuated by a hand-operated screw, the workman turning the screw to force the cutting edge into the moving body of metal to be cut. Very soon, however, the slide-rest screws were connected with some rotating part of the machine tool, lathe or planer, so that the workman had no work to do in the actual operating of these "self-acting" machine tools. He was thus relieved of all manual labor in the actual removing of metal, but needed great skill and intelligence to give the cutting tools their best forms, present them to the work at the best angles, and give the work the greatest velocity possible. Some workmen produced vastly more work than others with precisely the same equipment, where self-acting tools were used.

The aim of the factory manager is to make the same means produce the same piece at a maximum rate and minimum cost, no matter what workman is employed. Hence the self-acting machine tool was very early advanced to the semi-automatic tool, in which the cutters are sharpened and adjusted in fixed positions by the tool-maker, and the machine tender is required only to perform a few simple duties, involving neither discretion nor the exercise of judgment. His labors are confined to placing rough pieces in the machine, throwing cutting tools into action, and replacing the finished pieces by fresh rough pieces. But, even with the semi-automatic machine tools, some workmen produce more finished pieces than others, owing to superior intelligence and aptitude and willingness, and hence, in all cases where the size of work and the quantity of pieces demanded will permit, the full-automatic machine tool, which both handles and finishes the work, is now employed. The result is the diminishing of labor costs to a mere fraction of the labor costs incurred in producing the same piece by machine tools of the general "self-acting" class. With the full-automatic machine tool, the labor costs of work production are confined to the tool room; material, power, and lubrication, and the apportionate share of general expense, added to the tool-making account, make up the whole flat cost of the piece produced, and—a matter of the highest commercial importance—the manager finds his piece cost remaining nearly constant. If it varies, it is only in accordance with obvious



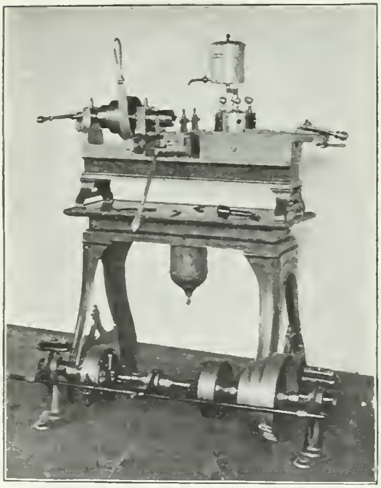
AN ENGLISH CAPSTAN LATHE.

Admits a 2-inch bar through spindle, and can turn a length of 9 inches. The turret slide is self-acting and self-stopping, and the turret can be made to operate automatically or not at will. Made by James Archdale & Co., Birmingham.

causes, and not at the whim of the machine tender, who is indispensable in the case of the semi-automatic or self-acting machine tool, and who is wholly intractable and ungovernable, and can and does make work costs large or small at his own pleasure.

Maudslay's accurately moved slide of the slide rest is the foundation of the tool-maker's art, because no cutting, rolling, squeezing, hammering or abrading tool can be effective as a producer of uniform metal-shaping effects except when guided by a "closely" fitted sliding support. The word "closely," used in this connection, has wide limits of variation, and may mean a hundredth part of an inch in the guides of a large steam hammer, or the fifty-thousandth part of an inch in the slide of a watch-part making machine.

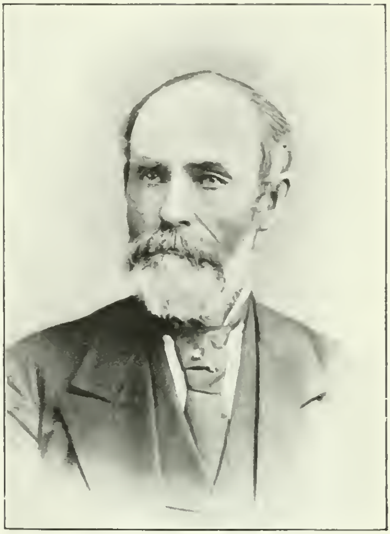
Maudslay's slide rest placed the English tool makers, for about half a century, in advance of all others, and led the English machine-tool makers to the belief that they had reached perfection and could rest where they were, because they led the world in 1845. But Maudslay's slide rest was really a very primitive element, whose powers were capable of expansion to an almost unlimited degree by compounding, and making one moving piece carry, not one single cutting edge adapted to produce one single geometric surface, but a multitude of cutting edges, adapted to be automatically moved in various directions and so to produce finished metal surfaces of any form and relation to each other on the same piece of work. This highly superior development of the slide rest is most widely applied in the form of the "turret," called the "capstan" or "capstan head" in England. The turret is purely an American invention, or at least as much so as the slide rest was an English invention. There is no doubt that both the slide rest and the turret, and perhaps even the multiple-spindle machine tool, are very old inventions. But Maudslay was the first to make a slide rest with sufficient accuracy to produce fairly good machine work, and Henry D. Stone, at that



EARLY SCREW MACHINE.

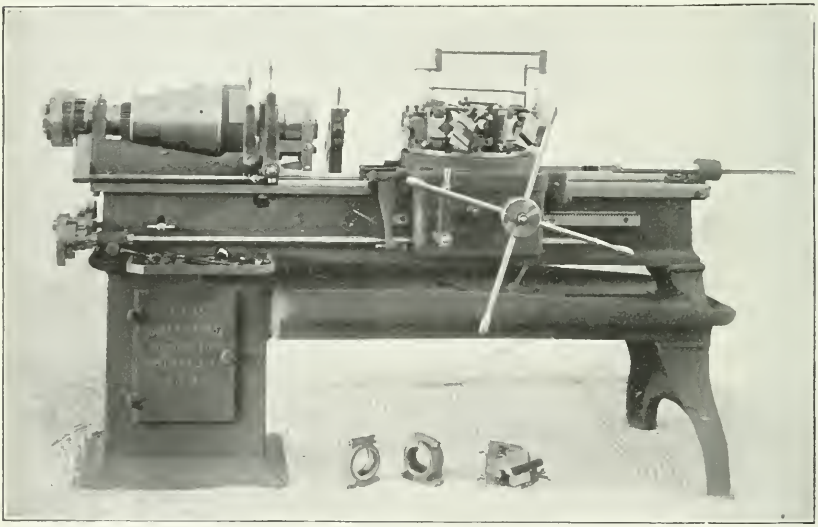
One of the first forms given to the turret lathe by Henry D. Stone. Made by Jones & Lamson about 1857.

time residing in Windsor, Vermont, was the first to comprehend the advantages of applying to Maudslay's slide rest a revolving head carrying a number of metal-working tools, and capable of being either revolved or locked to the slide at the will of the operator. Thus he made the first great step in advance in machine-shop tools after Maudslay's introduction of the slide rest.



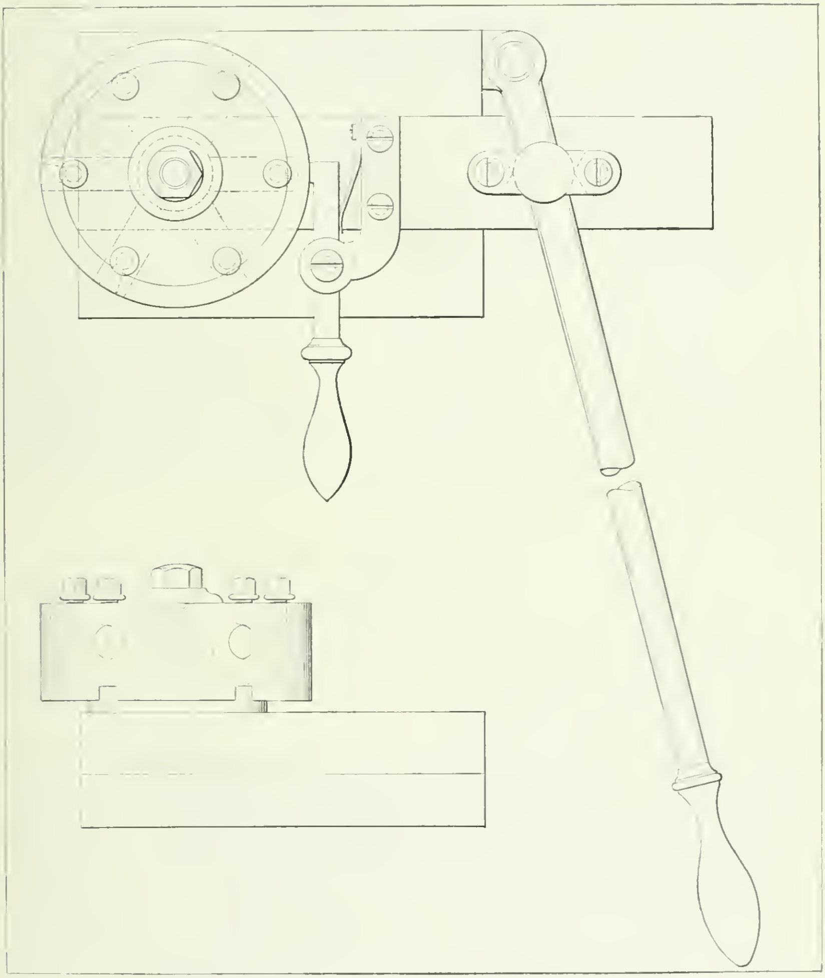
HENRY DAVID STONE.
The first great improver of Maudslay's slide rest.

Henry D. Stone was born at Plainfield, New Hampshire, August 20, 1815, and died at Windsor, Vermont, in 1898. He learned the millwright's trade at Woodstock, Vermont, and was afterward with Robbins & Lawrence, who were among the foremost of American machine-tool makers up to about 1857, when they failed in business owing to shortage forfeitures in a contract for arms furnished to the British Government, which enforced the penalties and ruined the unlucky contractors. September 20, 1899, I saw an admirable milling machine built by Robbins & Lawrence at Windsor, Vermont, in 1852, at work and held in high esteem in one of the best equipped and most modern machine-tool shops in existence; this single instance sufficiently attests the high standing of the firm, who were first of all the world to comprehend the possibilities of the milling machine in machine-part production. Upon their failure, Stone and another leased the Windsor establishment and began the manufacture of sewing machines, and this work was finally merged into the machine business of Jones & Lamson, Windsor, Vermont, Stone becoming superintendent. Stone's patents on the turret machine were taken out about 1858, and grew out of his accidental observation of some sort of a revolving head used on a bolt cutter at Hartford, Connecticut. He instantly comprehended the vast possibilities of the turret, and at once proceeded to design and produce a turret machine in the form of a lathe, having a work-carrying spindle driven at variable speeds, a cross slide on the lathe sheers carrying two tool posts in front of the axial line of the live spindle and two tool posts in the rear of the spindle axis, and having, in place of the tail spindle or foot stock of the lathe, a substantial slide of considerable traverse parallel to the spindle axis, and carrying on its unobstructed upper surface a turret, supported on a vertical axis, having six radial holes in the plane of the spindle axis, and capable of being automatically turned and locked by the traverse of the slide which operated it. Thus, instead of the single cutting edge carried by Maudslay's slide rest, this new tool devised by Stone carried four tools in the cross slide, and six tools in the turret, all fixed, ten cutting edges in all, and each one capable of being brought into definite action on the work in proper sequence. This so enormously amplified the powers of the self-acting lathe as to enable wholly unskilled laborers, and even boys and girls, to produce small machine parts at a very trifling fraction of the labor cost of the same parts when made by the most expert turner on a self-acting engine lathe fitted with Maudslay's inventions. Stone's patents were not well drawn, and other machine-tool makers promptly took advantage of the opportunity. Brown & Sharpe and Pratt & Whitney very soon became large producers of turret machines, and the turret is now applied to machine tools of all weights and descriptions. To H. D. Stone, however, belongs the credit of having first seen and compre-



THE JONES & LAMSON FLAT-TURRET LATHE.

The turret is a flat circular plate, mounted on a carriage containing the controlling mechanism. The form and connections are designed to secure great rigidity and accuracy. Cuts 2-inch diameter up to 24-inch length.

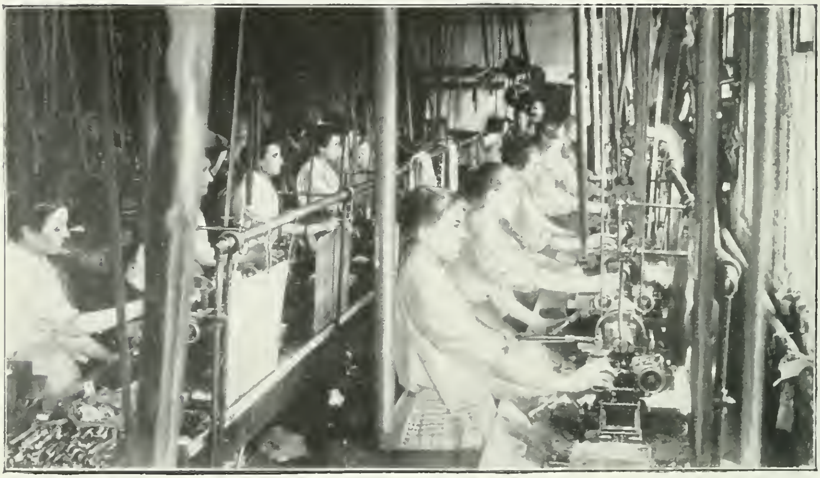


DRAFT OF THE TURRET MACHINE OF 1858.

Engraved, by the courtesy of George M. Stone, Esq., from the original drawing by Henry D. Stone.

hended the virtues of the turret, and thus laid the foundation for the use of that most valuable adjunct to the lathe, planer, milling and drilling machine, which, more than any other one detail of machine organization since Maudslay's introduction of the slide rest, renders possible the present amazing reductions in machine-production labor cost.

The form which the invention first took in his mind is clearly shown in the engraving on page 185, which is a reproduction of the



TURRET MACHINES OPERATED BY GIRLS IN THE SHOP OF THE HARTFORD MACHINE-SCREW CO.

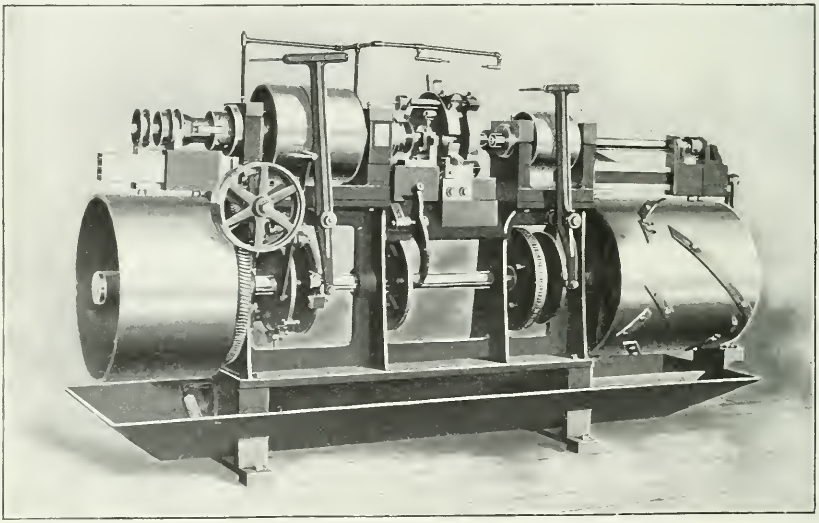
original drawing made by Mr. Stone and bearing the date 1858 in his own handwriting. This historic draft cannot fail to excite that interest which always attaches to authentic landmarks of human progress. As shown in the drawing, the original turret was intended to be operated by hand, there being one lever for the slide and one for the turret stop.

ROW OF AUMOMATIC SCREW MACHINES IN A BICYCLE MANUFACTORY.
The Lozier shops, Thompsonville, Conn., U. S. A.

But the hand-operated turret lathes, like all machines making direct use of muscular labor, were uncertain in production. Making very small pieces, the labor of traversing the turret slide is small and not very fatiguing, even when the turret machines are operated by boys and girls; but with these small turret machines celerity of movement and constant application were demanded of the operator, who could increase or diminish the part production within wide limits of variation without infringing the unwritten laws which govern the shop operative, and often forbid censure of the workman by the overlooker, even when the overlooker is convinced that the operative is willfully lax in the management of the machine entrusted to his or her direction. In general terms, all machine production which is dependent for its rapidity on the workman must be uncertain; even where the workman is sincere, and earnestly strives for the best results attainable, fatigue and physical condition often prevent reaching the maximum output, so that with semi-automatic machine tools it is common practice to estimate the probabilities of daily production at two-thirds, only, of the maximum rate of the machine when operated by a tool-maker or foreman. The only known remedy for this serious under production is the full-automatic machine tool, which does not depend in any way upon any operative below the grade of tool-maker.

CHRISTOPHER MINER SPENCER.

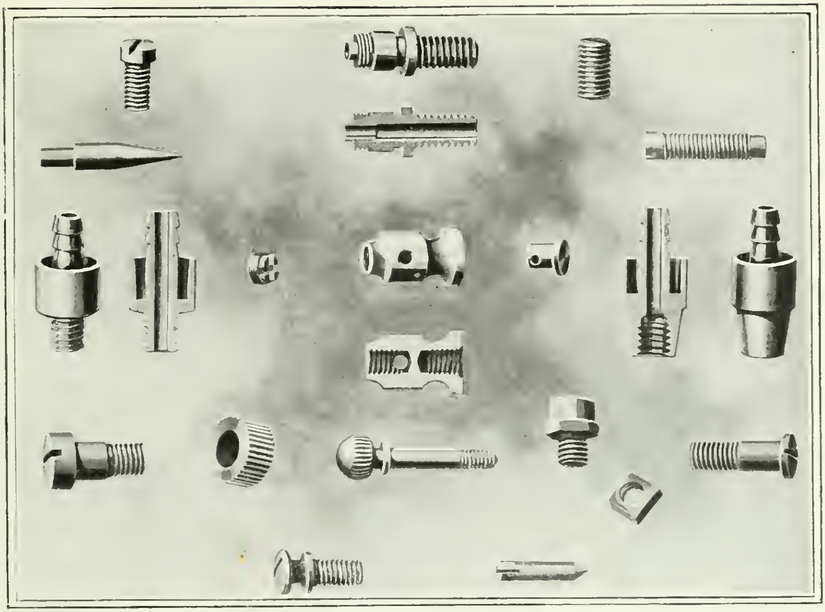
Christopher Miner Spencer, born at South Manchester, Connecticut, June 20, 1833, was the first to comprehend clearly the vast savings in machine-part production which are rendered possible by converting the semi-automatic turret machine into a full-automatic tool, capable of producing almost any shape of small metal piece, without human intervention beyond the placing of a bar of metal within reach of the feeding mechanism of the machine. Metal-working machines have not yet been so made that they can, of their own volition, go to the stock rack and select bars suited to the work they are fitted to produce; but at the Hartford Machine-Screw Company's works, where the Spencer automatic turret machines were first placed in large use, it is the practice to use, say, one machine tender to ten automatic turret machines, with the result that the observer may often gaze down the long vista of a screw-machine room, and see hundreds of full-automatic turret machines busily engaged in the production of small machine parts without a single workman in sight. This magnificently economical result is due to the work of Maudslay, supplemented by that of Stone, and placed beyond the hindrance of human intervention by Spencer. From Maudslay to Stone covered a period of nearly fifty years, and from Stone to the final completion of Spencer's work, now only just fairly on the market, nearly fifty years more were consumed, so that it may be said, with tolerable accuracy, that a whole century of observation and effort on the part of by far the best and most intelligent mechanics ever known in the history of the human race, has been consumed in perfecting the slide rest and utilizing the full scope of its powers.



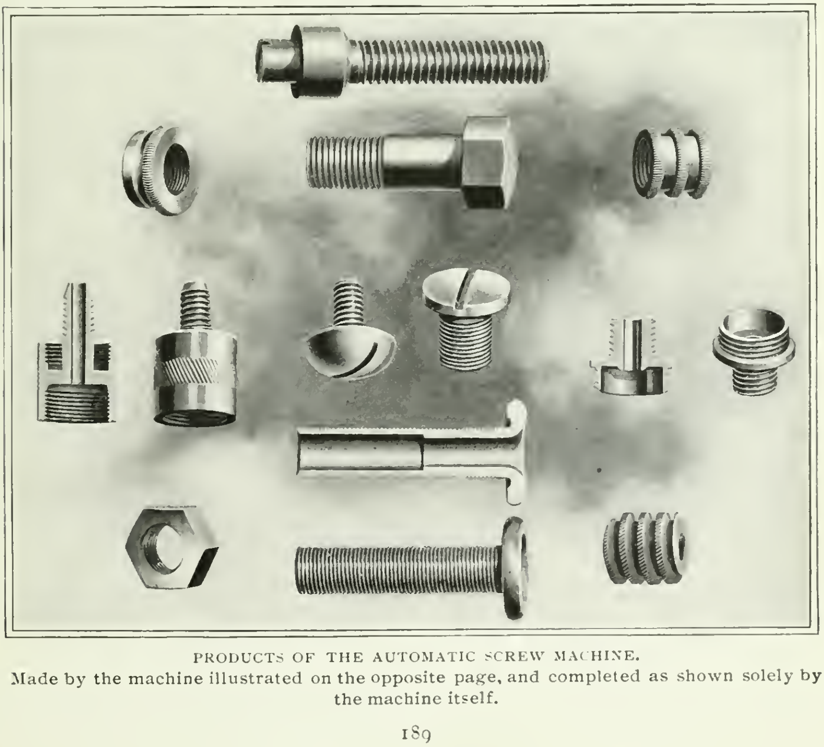
LARGE DOUBLE-TURRET AUTOMATIC SCREW MACHINE.

Chuck takes up to 1⅝-inch diameter, making a cut 4½ inches long. Each turret holds five tools. Spencer Automatic Machine Screw Co.

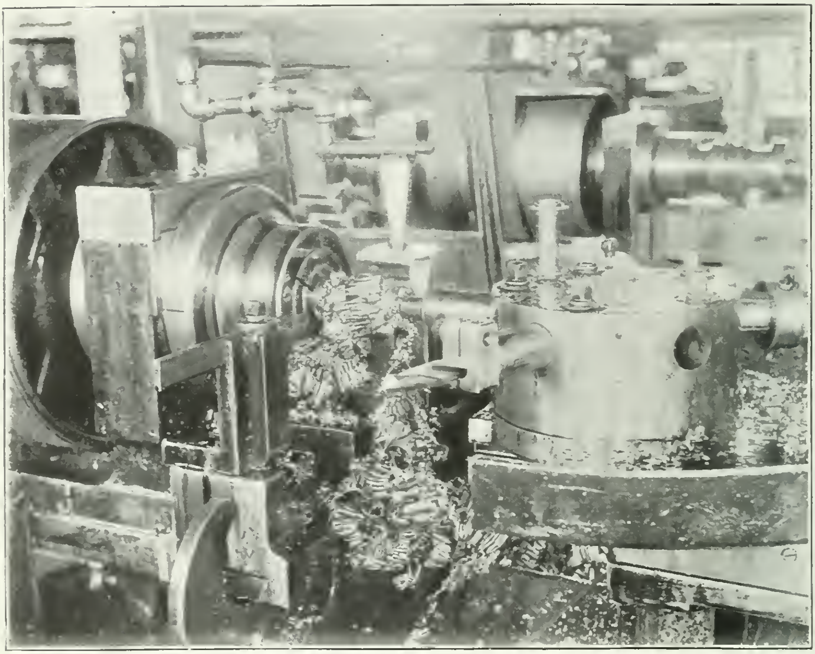
Spencer's name is widely known in connection with drop forgings, turret machines, and guns, both rifles and shot guns, small arms having been both his triumph and his bane. Spencer began his mechanical career by serving a sixteen-months' apprenticeship with Samuel Loomis, of South Manchester, Connecticut, cotton machinery builder



PRODUCTS OF THE AUTOMATIC SCREW MACHINE SHOWN ON PAGE 195.



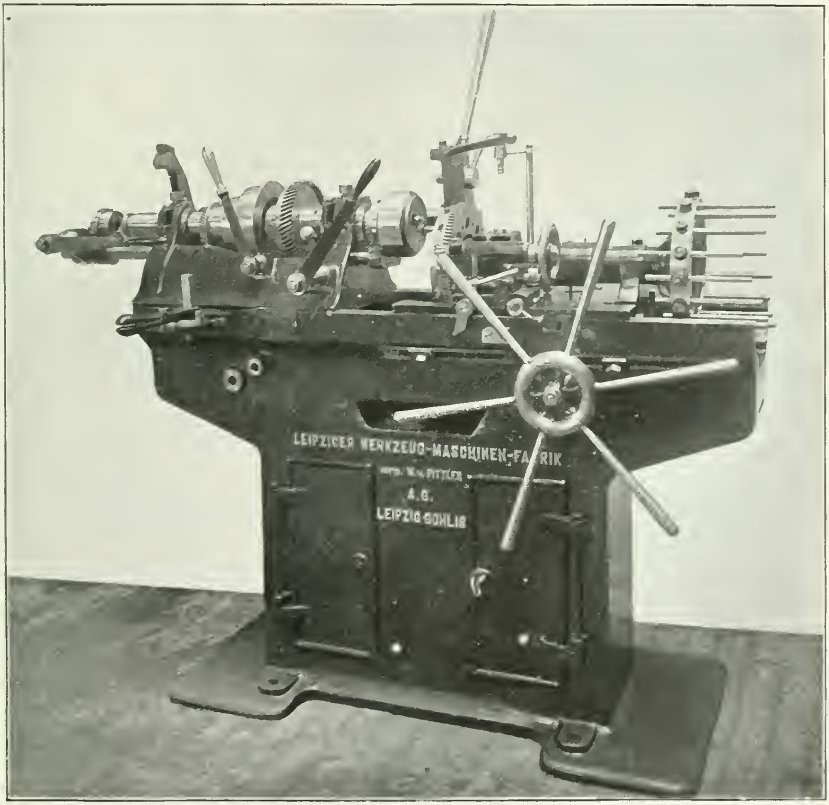
PRODUCTS OF THE AUTOMATIC SCREW MACHINE.
Made by the machine illustrated on the opposite page, and completed as shown solely by the machine itself.



BROAD CUTS ON BICYCLE HUBS.

The Spencer automatic screw machine at work in the Lozier bicycle shops.

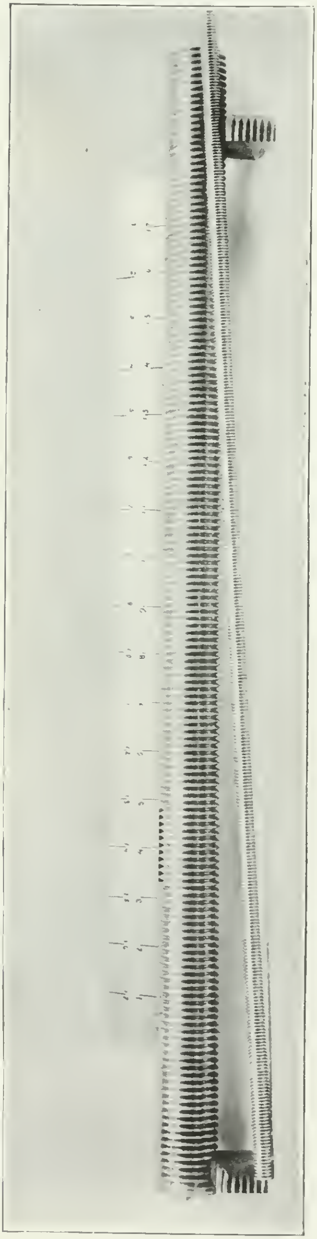
and repairer. Next he was with the Cheneys, of South Manchester, now the great silk-mill owners, then only small makers of sewing silk. From thence he went into a locomotive-repair shop at Rochester, N. Y., and from the locomotive shop to the Ames shops in Chicopee, Mass., where he assisted in the production of musket-stocking machines for the Russian Government. He then went back again to the Cheney Brothers, in South Manchester, and there invented his first rifle, which was patented in 1860. The wealthy Cheney Brothers financed the Spencer rifle, giving the inventor a bonus of $5,000, a royalty of a dollar on a gun, and the position of superintendent of the Boston factory, where the manufacture of 200,000 Spencer rifles for the United States Government was very soon commenced. From the Boston rifle factory Spencer went to the Amherst gun shop, organized to work Spencer's inventions in sporting guns, and there lost about all the money he had. After this unfortunate venture, in company with C. E. Billings, he began the manufacture of shot guns at Hartford, Conn. The shot gun did not make money, but Billings & Spencer had laid down a fine drop-forging plant and their drop forgings are now known the world over. At the end of the last gun venture, Spencer turned his attention to the turret machine and made it automatic, and the possibilities of this new invention of his were fully comprehended by Mr. Fairfield, at that time superintendent of the Weed Sewing Machine Company, of Hartford, who at once founded the Hartford Machine-Screw Company. This concern used the Spencer automatic machines in the making of machine screws of all sorts and sizes, producing also to order an almost illimitable variety of small machine parts, with very great commercial success. Spencer went with Fairfield, and was on the high road to large wealth, when



REPETITION LATHE—A VARIATION ON THE TURRET OR CAPSTAN TYPE.

The entire set of tools for a given piece can be taken out of the tool head and replaced by a complete set for a totally different piece in a few minutes. Accuracy of finished parts is obtained by using a roughing and a finishing tool for every important cut. For extreme accuracy, even a third tool may be used. The number of tools carried is ample to leave enough others for forming, tapping, screwing, etc., so the piece may be finished in one chucking. Made by the Pittler Co.

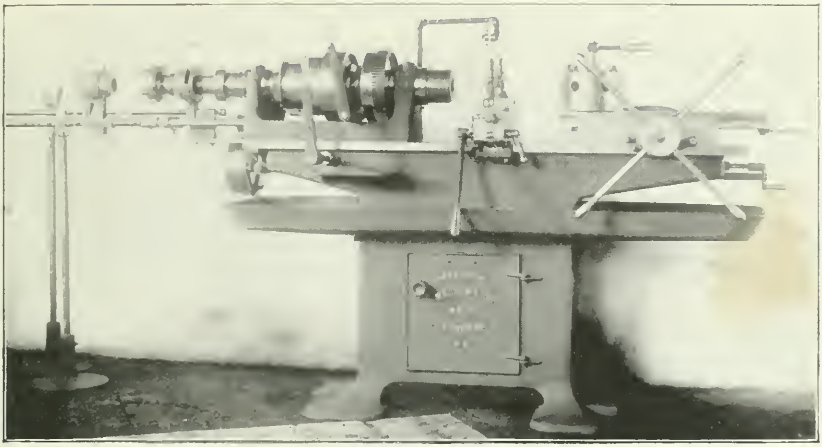
he was unlucky enough to conceive the idea of the "trombone" shot gun, the most rapid fire sporting gun known; he sold out of the Hartford Screw Company and started a shot-gun factory at Windsor, Connecticut, six miles north of Hartford, where he sunk $30,000, and again turned his mind to the automatic screw machine, and produced the automatic double-turret machine, which can make almost any small machine part of generally circular outline, without human intervention.



AN EXAMPLE OF ACCURATE THREAD-CUTTING ON THE AUTOMATIC SCREW MACHINE.

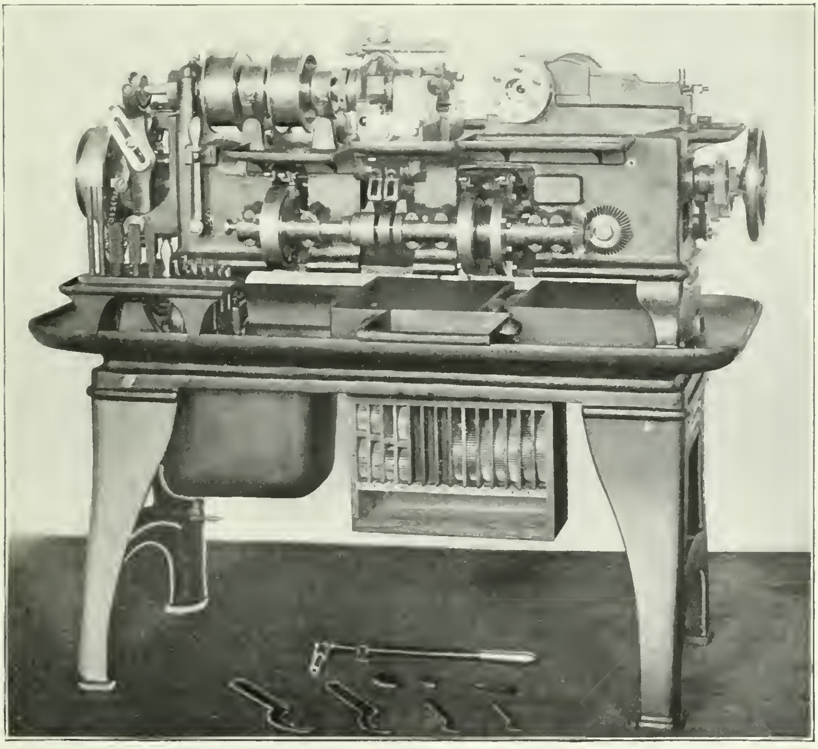
Thread made with Hartness automatic die on the flat-turret lathe.

In the operation of the semi-automatic turret machine, the workman has to move the turret-conveying slide toward and away from the work-conveying spindle varying distances at varying rates of travel, and to move the cross slide in both directions. The full-automatic machine must, of course, make approximately the same motions and these motions vary in sequence and extent for every different piece made. These motions of the machine parts must be given, in the full-automatic machine, by means of cams placed on a shaft which makes one revolution during the production of each piece of work, and at first sight the full-automatic turret machine would seem impossible because of the vast number and cost of the different sets of cams required to adapt the machine to anything like general use. Spencer met this seemingly insurmountable objection by inventing a blank cam cylinder of large diameter, to which small pieces of plain iron bars of



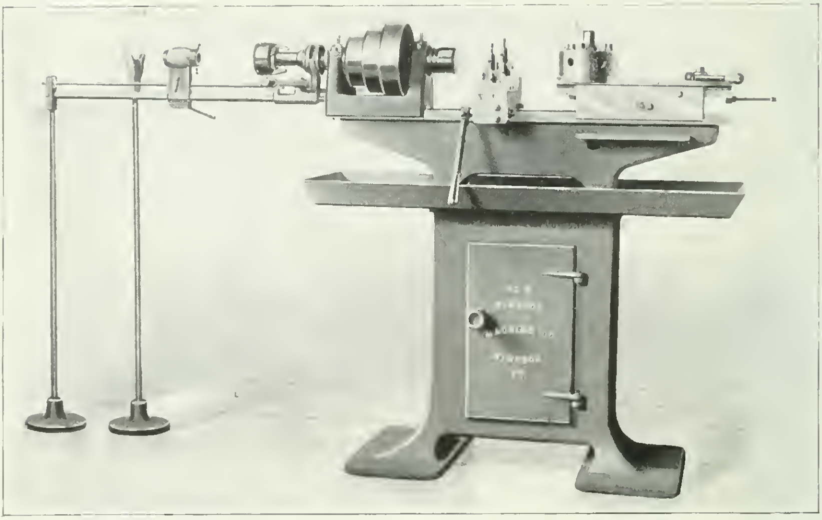
A SCREW MACHINE, 16-INCH SWING, 2-INCH CHUCK CAPACITY.

Automatic chuck and wire feed ; power feed to turret and oil pump.
Made by Windsor Machine Co.



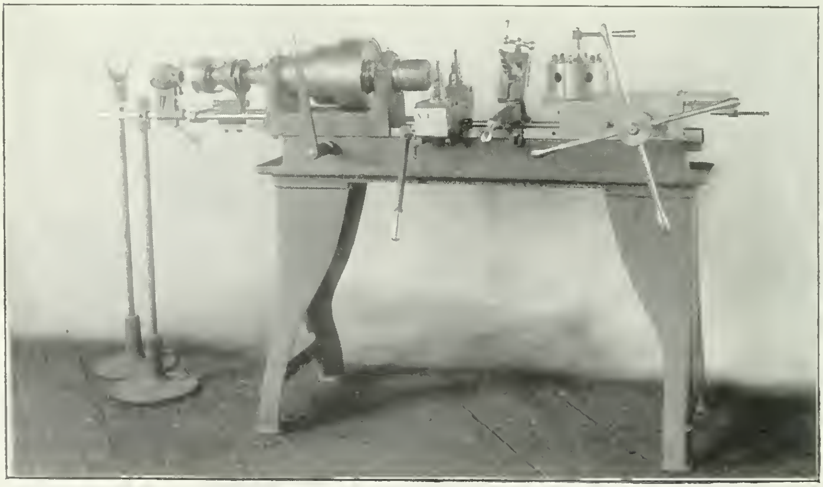
AUTOMATIC SCREW MACHINE TURNING ½-INCH STOCK TO A LENGTH OF 2 INCHES.

Made by Brown & Sharpe.



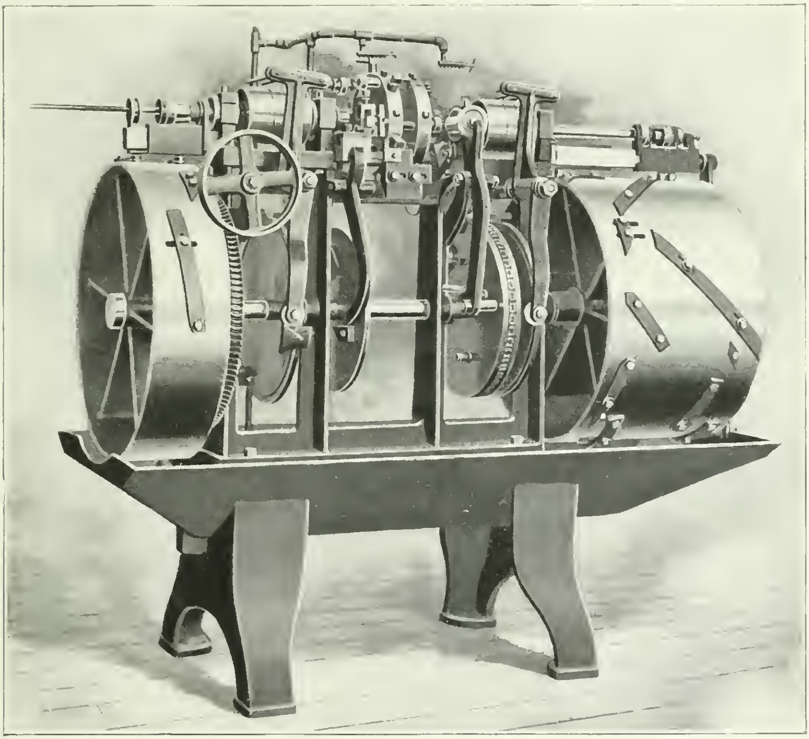
SCREW MACHINE, 1-INCH CHUCK CAPACITY, 5½-INCHES WORKING LENGTH.

rectangular section could be screwed in any desired position, so as to constitute an endless succession of different cams, suited to produce any required movements of the turret machine members, at no cost beyond the small expenditure of time required to "set up" the cam strips on the cam cylinder. The importance of this form of cam was wholly overlooked by the patent attorney who prepared Spencer's ap-



A MONITOR LATHE FOR BRASS WORK.
With auto-chuck, wire feed, and chasing apparatus. Made by Windsor Machine Co.

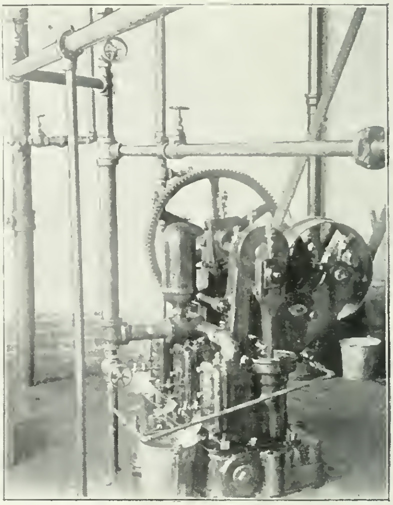
plication for patent on the automatic screw machine, and so was never covered by any claim whatever. This universal cam was, and is, however, one of the most important of all the inventions ever made in metal-cutting machines, and deserves to rank with Maudslay's slide rest and Stone's adaptation of the turret to the general requirements of machine-part production.



SPENCER DOUBLE-TURRET AUTOMATIC SCREW MACHINE, SHOWING THE "PROTEAN CAM."

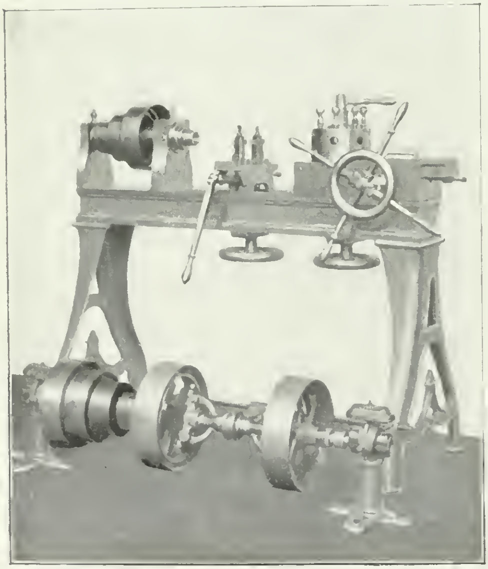
The double-turret machine has a forward and a rear turret, acting in conjunction with a primary and a secondary spindle. Thus two series of operations may be simultaneously performed on opposite ends of the same piece by two independent, complete sets of tools.

Here then, at last, three-quarters of a century after Maudslay had shown that a lathe could hold and guide its own cutting tools better than any workman could hold them, Spencer produced the lathe which could take a bar of stock and work it up into small machine parts wholly without human intervention. Parkhurst, of Middletown, Connecticut, had in the Pratt & Whitney shops applied the hand-operated push collet to feeding and holding round rods in the



OIL-CIRCULATING PUMP, LOZIER SHOPS.

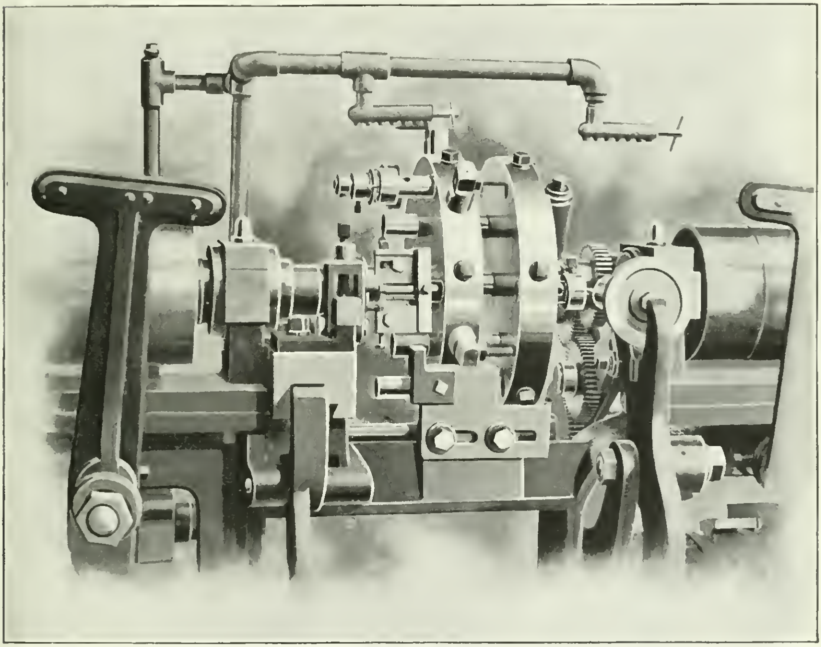
An automatic auxiliary to the automatic screw machine. The entire shops are piped from the pumps, the used oil being taken from the machines, passed through an oil-cleaning machine, and returned for use. The oil circuit is continuous, and needs no manual intervention.



AN EARLY MONITOR MACHINE

Jones & Lamson, about 1881.

turret machine live spindle. Spencer took the draw-back collet for the same purpose, both the draw-back collet and the push collet for holding work in rotating tool spindles being before known. With the collet for holding the bar of stock in the live spindle, and the protean cam, the full-automatic screw machine became a universal tool, of as general application to the production of machine parts as the lathe, planer, or drilling machine, and made more, better, and cheaper work than was ever before possible. This was seemingly the end of the possibilities of machine production in small work. The weight of a long bar of stock prevents the turret machine from working bars more than four or five inches in diameter. The bars are never quite straight, and never run true when gripped by the collet in the live spindle, and a bar, say 4 inches in diameter and 15 feet long, when held in a live spindle not more than, say, 36 inches long, and gripped at the extreme end only, cannot be so supported as to revolve without an unfavorable influence on the accuracy of the work produced. Again, large turret lathes are extremely expensive, and there is but a very small demand comparatively for round pieces over two or three inches in diameter in machine construction. These considerations must, so far as can now be seen, limit to less than 5 inches, and perhaps to less than 4 inches, the diameter of long bars to be worked up in the turret machine. Bars of $3\frac{1}{2}$ inches diameter are the largest known to me as being worked in a turret machine, and I believe only one machine of this size is in existence.

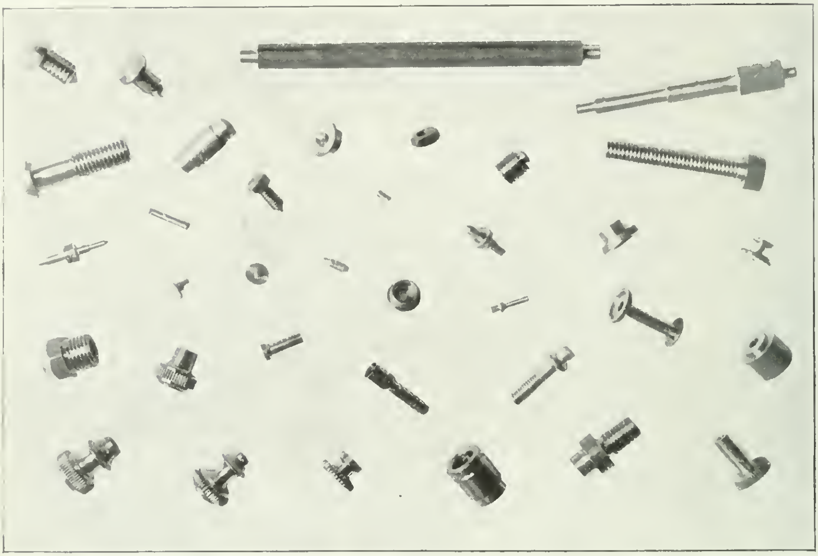


ENLARGED VIEW OF THE DOUBLE TURRET AND SPINDLES.

The primary spindle carries the rod, which is operated upon by the tools in the forward turret; the secondary spindle carries the detached and partially completed piece, while the work upon it is completed by the tool in the rear turret. All operations, including ejection of the finished piece, are automatic Made by the Spencer Automatic Machine-Screw Co.

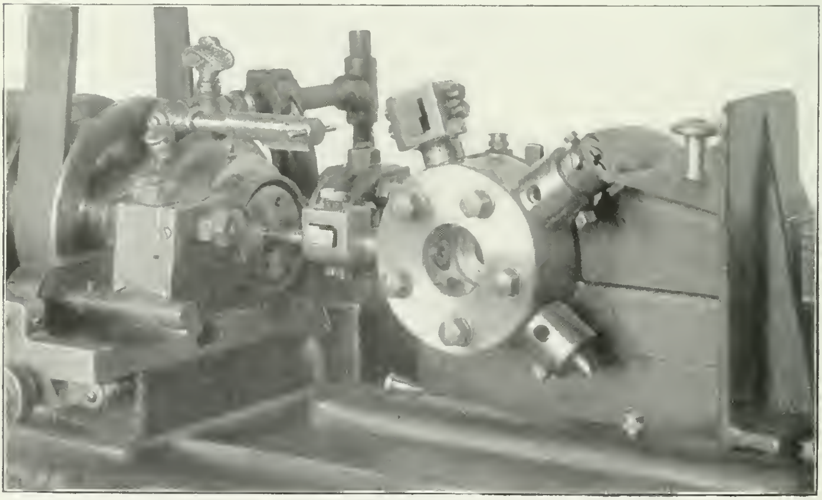
The full-automatic turret machine was not, however, the limit of the possibilities of the metal-working lathe when viewed by a mind as comprehensive as Spencer's. His final inventions in turret machines reach the superlative degree of the double-turret screw machine, which has vastly greater powers than the single-turret machine.

The single-turret lathe can do everything that the most skillful turner can do to a piece chucked in the live spindle and running "in

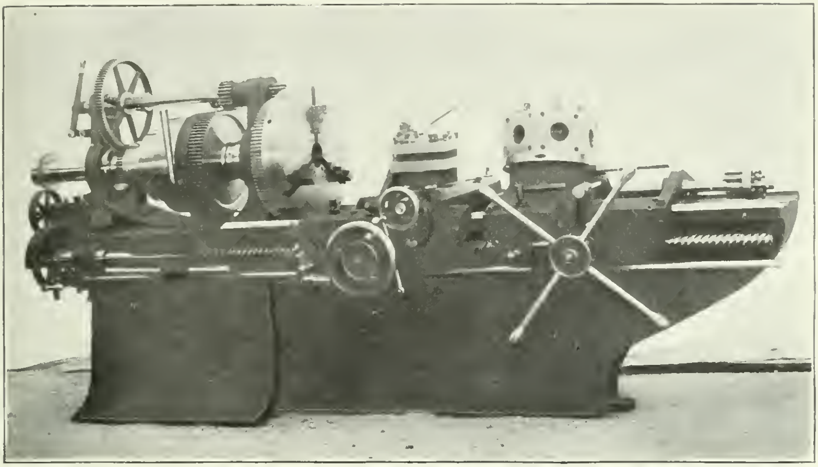


MORE EXAMPLES OF THE RANGE OF WORK POSSIBLE ON THE AUTOMATIC SCREW MACHINE.
The pieces photographed above are the products of the machine shown below.

the air," as the shop expression has it. A piece of metal so held has its sides and outer end fully exposed, and these may be given any desired shape, without removing the work from the chuck. But many pieces



TOOLS IN POSITION FOR MAKING A SHOULDERED SCREW.
One of the finished screws is seen immediately under the chuck. The machine is one of Brown & Sharpe's "No. 00."

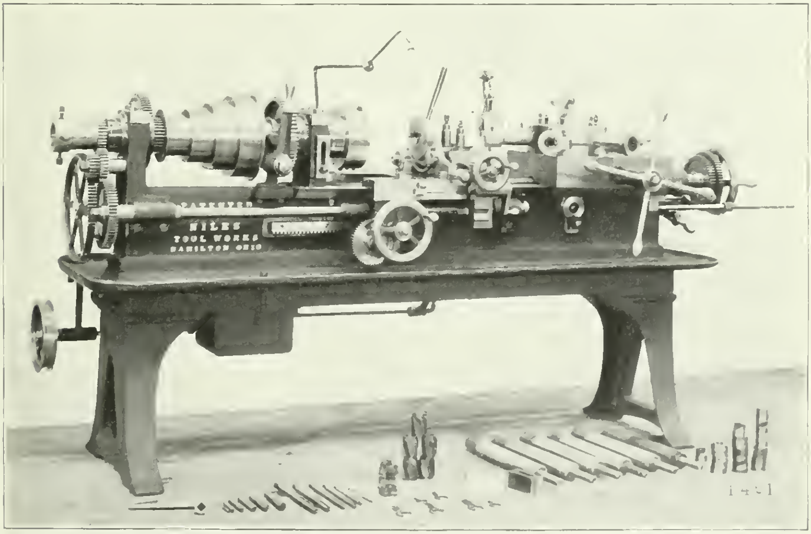


A TURRET MACHINE FOR A WIDE RANGE OF WORK.

The succeeding issue will show several views of special tools fitted in the machine for finishing certain parts of machinery. Made by the Gisholt Machine Co.

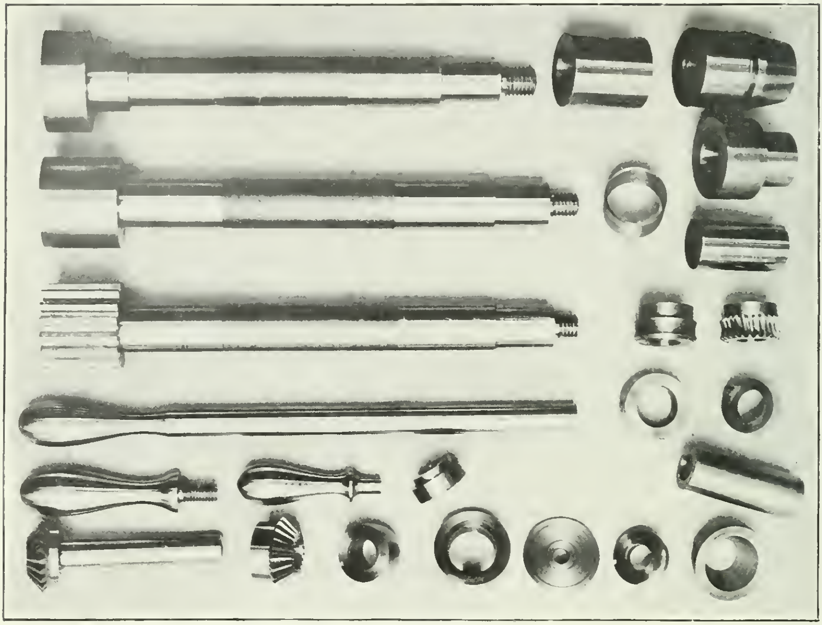
require cuts to be made on the third surface, which is not accessible, being inside of the chuck of the live spindle or otherwise supporting the piece as it is worked.

To meet this case, Spencer introduced a second chucking spindle,



SCREW MACHINE FOR BOLTS FROM ⅜-INCH TO 1-INCH DIAMETER.

The turret revolves and locks automatically, the point at which the revolution occurs being adjustable and indicated by a gauge at the front of the turret slide.
Made by Niles Tool Works.



PRODUCTS OF THE FLAT-TURRET LATHE.

opposed to the live spindle, and capable of moving towards the live spindle and grasping a piece of partly completed work while yet held by the live spindle, and, when the work is released from the live spindle, this second chuck-carrying spindle is made to move backward away from the live spindle, carrying the incompleted piece to a new location, where it can be fully completed by tools carried in the double turret. Thus, a screw which requires a slotted head may have its thread, body, and head formed while chucked in the live spindle: the second spindle comes forward and surrounds and grasps the screw up to the head, and as soon as the screw is cut off from the bar held in the live spindle, the second spindle travels backward and stops in such a position that tools carried by the second turret can shave and slot the screw head, or bore a cross hole through it and drill and tap the head to form a combined screw and binding post for electrical work, for example. Thus it produces, completed on a wholly-automatic machine, pieces which could only be made by two, three, or four operations on as many different machines by the best practice known before Spencer's magnificent inventions, which have great powers of cost reduction coupled with the surprising simplicity of construction which is the hall-mark of genius.

WORKS MANAGEMENT FOR THE MAXIMUM OF PRODUCTION.

By J. Slater Lewis.

II.—THE LABOUR FACTOR IN THE INTENSIFICATION OF OUTPUT.

ALL practicable methods for the reduction of cost resolve themselves ultimately into methods of intensifying production. There are several directions in which this aim may be pursued. The great factors of production are manual skill and dexterity, intelligence in inventing and applying special devices for facilitating the handling of work, efficiency of the machines employed, the relationship which these elements bear to one another—viz., the organisation or environment amidst which they function—and, last but not least, design.

To intensify production—that is, to increase the output, considered per working period of time, without increase of plant—we may seek to modify any or all of these five factors. We may stimulate labour, by extra reward, to a greater average of exertion; we may foster and encourage the minor inventive faculties of all engaged in the work, officials and workmen alike, and lead them to offer suggestions, each perhaps of no great importance in itself, but capable in the aggregate of influencing production in a favourable sense; we may give close attention, and be prepared to give a thorough and exhaustive trial, to new types of machinery, particularly of the modern class of "exact" partly-automatic machines; we may overhaul, or, better still, recast our methods of administration in the manner reviewed in the first article of this series; and, finally, we may scrutinise every detail of our standard designs to see whether they are in all respects arranged for manufacture under the latest and best conditions.

The question of the stimulation and reward of labour is a wide one—perhaps the widest and most difficult of all. I do not propose here to raise the vexed question of trades unionism, either in the way of justifying its aims or of criticising its methods; I propose to deal, rather, with the concrete details of methods of payment for work done. The simplest and oldest of all such methods is the purchase of service by time. Its obvious disadvantage is that there is no constant

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The ruling idea of modern industrial economy is the avoidance of waste, either of effort or material. And the mechanical world sees, with ever increasing clearness, that effort which fails to produce the maximum possible effect is to that extent wasted. Mr. Lewis relation between money expended and work performed. In the simplest kinds of labour, mere muscular exertion for instance, this introduces already an element of uncertainty, although the *average* work of a man may be fairly well known. But in all operations into which skill, and to a still greater extent intelligence, enter, the defect of this method of remuneration becomes patent and glaring. The relative intelligence of men cannot certainly be gauged and averaged as can their muscular activity, and even the ultimate degree of mere manipulative skill to which men may attain under the same opportunities varies within wide limits.

The future of any particular business, considered as an industrial unit, or of a whole industry regarded as a national unit, depends, however, upon the degree of effectiveness of output to which it can be evolved by the most skilful management. The more ineffective the methods of calling forth the best energies of labour, the shorter-lived will be the period of supremacy of that industry in the markets of the world. The question of the reward of labour becomes, therefore, a vital point when we look round on the rising industrial activity of other and younger nations, and realise that the alternative before us is either to match, and if possible surpass, them in intensification of productive output, or find ourselves, with each succeeding wave of slackness, and shrinkage in volume of business, less able to keep our men in work, and the commercial wolf from the door.

Whilst there is, and always will be to some extent, a description of work of which it would be most difficult to measure the due economic reward save by the indirect method of measuring and paying for the actual time occupied on it, yet, as will be more fully enlarged on under the head of "specialisation," this particular class tends *relatively* to diminish. The ordinary operations of the manufacturing engineer do, as a matter of practice, tend towards repetitive work, and it is, therefore, necessary to consider this class more especially.

To abandon the system of payment by time and to substitute payment for work performed is a considerable economic advance, alike from the point of view of the employer and the workman. To the former it means, under the most inelastic system, at least the substitution of a known for an unknown element in cost. To the latter it opens up, for the first time, the possibility of realising, even though only upon a small scale, the satisfactions of individual enterprise which otherwise do not exist for him. But even where we agree that

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and Sir Benjamin Browne, in pointing the way to better management, and Mr Roland, in exhibiting more effective mechanical appliances, address the engineering world upon the most vital questions now demanding its thought and study. THE EDITORS.

the workman's reward shall be proportional to his work, this reward may be made immediate, definite, and personal, or dependent on the coöperation of numbers, and realised only as a share of a general result. The former of these is exemplified by all systems of the "contract" or "piecework" variety, and the latter by the so-called "profit-sharing" methods. However useful these last for the development of *esprit de corps* in certain special kinds of business where the volume of trade, and consequently the statistics of employment, are fairly constant, it cannot be said that they fulfil the vital condition of an immediate and personal spur to the intelligence of the individual operative. Of these two classes of remuneration by results we must look rather to the piecework than the profit-sharing variety to produce direct and immediate reactions.

It cannot be pretended, however, that the piecework system, as usually employed, commends itself as a satisfactory, still less as a final, solution of the problem. We obtain, it is true, an immediate definition and limitation of cost, coupled with a strong and direct inducement for the employee to exert his best endeavours to increase and intensify production. At least, this is the theory; but in practice it is a true statement of the result only within very narrow limits. The defect of the method is, that when once the workman has begun to derive a profit from the transaction, the employer has no *direct* interest in his further exertions, but only the indirect advantage of a stationary labour-cost coupled with a greater intensity of output. The general result of this is, of course, well known and understood. There inevitably comes a time—if the workman continues to improve in skill, or to give evidence of a continuous and successful application of intelligence to his work—when the gains of the workman appear excessive compared with his former earnings as a mere supplier of labour by the hour. The employer would be more than human who did not, at this stage, ask himself the question, "Have I not made a mistake in fixing prices?" When this question is answered affirmatively, a reduction of rates inevitably follows. The suzerain power insists on remodeling the convention, and the result is frequently—not peace, but soreness. Of course, where much piecework is in vogue, the trouble does not necessarily arise with as much frequency as might be expected, for a very good reason. As soon as the workman finds himself approaching the point at which his extra earnings tend to rise beyond the limit at which the traditions of the shop teach him the reduction may be expected, his efforts slacken. He makes no endeavour either to improve in skill, or to trouble himself about little tricks for the better management and handling of his job. His interest for the future is barred, and the net result amounts to this—that he has adopted a somewhat greater intensity of production, and receives a somewhat greater constant remuneration than when he was on hourly wages.

That there is a gain, both to man and employer, is obvious; but that it is a slight and limited gain is also obvious. Abstractly considered, the method is remarkable no less for what it wastes than for what it effects. From an examination of its defects we are enabled to formulate the conditions which must be fulfilled by a more satisfactory method. We require: (1) a minimum standard of remuneration based on the average attainments of hourly labour; (2) free and full incentive to the workman to improve upon this average, not merely up to a certain arbitrary stage of improvement, but without limit; (3) participation of interests between employer and workman in this improvement not merely in its early stages, but to the ultimate extent to which the intensification of output and consequent reduction of costs per piece can be carried, either by constantly augmenting manipulative skill, or by a series of small improvements in method. A theoretically perfect system of remuneration should not involve the constant comparison between the piecework earnings of the exceptionally clever or skilful workman, and his former earnings when neither exceptional skill or cleverness were asked for, nor sought to be rewarded.

It may be objected that this theoretical perfection is actually realised to the full by the piecework system, if only we assume that rates shall never be cut. This is, of course, true; but it is not the whole truth. The element of participation by the employer in the direct reduction of labour-cost is entirely wanting, and that such participation is essential and just can be seen readily enough. If it be true that the actual reduction is wholly due to the efforts of skill or of intelligence exerted by the workman, it is equally true that the opportunity for such exertion is provided by the enterprise, and perfection of technical and business organisation of the firm.

It is the absence of provision for reward of the employer's foresight and organisation, collaterally with remuneration of the workman's skill and intelligence, that is the fundamental weakness of the piecework system. The "big figures" go to swell the workman's earnings alone, and the employer feels that he must do something to preserve equilibrium. The only thing he can do is to cut rates. But this is like killing the goose that lays the golden eggs. The excessive earnings of the workman are certainly pruned away, but so, unfortunately, is his alertness to profit by every opportunity to intensify production. This is a moral effect that cannot be scheduled, or reduced to graphic form. On the other hand, there is no reason to suppose that the 25 per cent. or 30 per cent. advantage in intensification, which is the normal result of the adoption of pieceworking, is a natural limit of productiveness. Even though it be assumed that this represents the maximum development of more manipulative skill likely to result from any possible incentive that can be offered, no such assumption can be maintained as regards that class of work in which the application of wits can be made to influence the quantity of output. Limits cannot be set to the workings of intelligence, and it is certainly to the employer's interest to foster, and not to throw a damper on, such efforts. Yet the adoption of an arbitrary standard of maximum earnings cannot have any other influence than this. And while the employer has only an indirect advantage in the greater rapidity of production, and does not feel the benefit in reduced labour-cost per piece, when once a price for the work has been agreed upon, it is evident that he cannot afford to look with equanimity upon profits, which his organisation and foresight have rendered possible, going entirely into the pocket of one party to the bargain.

From these considerations the conclusion is forced upon us that, although pieceworking is a decided advance, other things being equal, over hour-wages, in realising a higher intensity of production, yet it does not in practice do as much good, as, at first sight, it seems to promise. It opens, but does not keep open, the door to that individual development of the skill and intelligence of the workman that we commenced by postulating as a desirable feature. And its failure to do this is because such development can only take place at the expense of the employer, and we are not able to bring into the calculations the share of the latter in producing the total result.

That these unsatisfactory features have tended to discredit the methods of payment by results cannot be doubted. From the workman's point of view, no less than from the employer's, there is dissatisfaction with a method that renders something short of absolute justice to either party; the workman is no less keen to look with suspicion on a periodical readjustment of rates than the employer is to question the expediency of permitting large balances to mount up in constantly increasing ratio. These admitted deficiencies have of late years, and particularly in the United States, led to attempts to remodel the fundamental basis of contract work, and to bring about a real identity of interests between employer and workman in the direction of uninterruptedly increasing the intensity of production, to the mutual benefit of both parties.

The essential peculiarity of this method is that a resultant saving of production-cost is divided between the workman and the employer, the proportion between the two shares being variable according to the special conditions of the work. It is manifest that, were the piecework system really efficient in calling out the best energies of the workman—not merely up to the "critical" rate (by which is meant the rate at which, in any particular shop, further reduction in cost would lead to a revision of prices), but beyond it to the ultimate practical possibility—the premium system would scarcely be a serious rival as regards popularity with employees, since, instead of the whole saving going to the workman, only a portion, depending upon the ratio fixed on, goes to him. But in the few cases in which evidence is available of the working of this method, the actual result seems to be, what indeed may be expected from the considerations discussed above, that production cost does tend constantly to diminish. This is because the important feature of the newer method is not that the saving is divided between employer and workman, but that no artificial barrier, no "critical rate" of earnings looms in front of the latter to dampen his activity and lead him to slacken his energies.

At the same time, the significance of a high rate of earnings by the workman is entirely changed. Of its satisfactory appearance to the man, nothing need of course be said; but it becomes also a satisfactory phenomenon to the employer. In fact, it is an index, not merely of increased intensity of output, but of actual reduction in direct cost per piece.

It would appear, therefore, that in the long run the premium system will tend to displace existing methods of remunerating labour. It has, of course, certain theoretical disadvantages which must be opposed to the benefits it offers. Its immediate incentive is not so strong, and it is, therefore, on this account perhaps more suitable for repetition work than for work recurring at comparatively distant intervals. The fundamental principle of the method—that rates once fixed are never to be cut, whilst conditions remain the same—will require very careful observance in order that the confidence of the workman may be won for it. And this principle may, in careless or unscrupulous hands, be made to clash with the necessity for revising the rates when alterations in design have taken place, or modifications of process have disturbed the original fixture. These are elements of danger peculiar to the system; because, *unless* the principle of permanent and unalterable rating is made and accepted in good faith by both sides, and so maintained, the premium method does not, in appearance at any rate, offer the same advantages to the workman as the older method. And its popularity would certainly be seriously shaken in any shop where alterations, under the special circumstances just mentioned, were made the excuse for reducing the workman's share in more than fair proportion.

Whilst upon the subject of the labour-element in production, something may be said as to the development of an *esprit de corps,* a tone, amongst the employees, leading them, or the progressive spirits among them, to feel that any expenditure of thought on their part, contributing to the welfare of the whole, will be appreciated and rewarded. The question is difficult, no doubt. The propounder of a suggestion naturally magnifies its importance and is a believer in its practicability. If it is ultimately accepted, in however modified a form, he is apt to assume to himself the whole glory, and to think himself unjustly treated if the reward is not proportional to his own valution of his services. But, as between the employee and the firm, the question is a simple one. It is the manner in which suggestions are commonly expected to reach the executive that is the most troublesome part of the problem. To filter from the workman to leading hand, foreman, and departmental manager is not only a long process but may easily be a stifling one. It is of those immediately above or under him that a man naturally feels the most jealousy. To snub the aspirations of a subordinate is too often a pleasurable exercise, and a man who has once received a rebuff of this kind is likely to keep his hints to himself on future occasions.

In certain kinds of business, and particularly where changes of methods are creeping in amidst an old-established organisation, it may pay to keep an open ear for this class of prompting. In many successful works, particularly in the United States, a generous policy has proved to be of demonstrated value. It is well, therefore, to consider whether, amongst other methods of increasing output, an organised plan of receiving and considering suggestions from all and sundry may not have an established place. A large percentage of these will, no doubt, but poorly repay the attention given to them. It becomes a matter of practical experience to determine whether, in any particular business, the gain outweighs the trouble. In any case, direct submission of all suggestions to the responsible management should be arranged for.

Closely connected with the subject of the living element in production is that of a well considered scheme of subordination, including every executive official in the establishment. A clash of authorities is one of the most potent factors of waste, delay and demoralisation, and evidences of it should be closely watched for with a view to tactful but immediate remedy. The duties and obligations of every class of official should form part of a carefully considered scheme, and when the whole has been decided, made the subject of a graphic chart; each person concerned should be provided with a written or printed schedule of duties. Nor is this of itself sufficient. Developments will arise from time to time, introducing new features not provided for in the original scheme. These should also be charted and form the subject of additional instructions reduced to writing. In great organisations like those of the post office and the railway and telephone companies, this method finds its fullest development; but even in comparatively small businesses, as soon as they become large enough to adopt the departmental system of organisation, the benefit of such a plan of controlling and regulating the less important members of the executive will speedily be felt, if judiciously and thoughtfuly arranged in the first instance. For those whose duties are matters of comparatively unintelligent routine, the introduction of time-tables of duties to be performed at certain hours, or on certain days, will also be of considerable assistance to the smooth working of system—if care be taken, particularly at the introduction of such a method of control, to see that the duties so detailed are carried out in the manner prescribed.

Another point of importance in connection with the *personnel* of large departmentalised establishments is that of adopting some method of periodically bringing together the heads of departments, and reviewing all the more important work in progress, item by item, each department stating the causes of delay if any, and instruction being noted as to expediting it. In my own practice I term this a "conference," and in connection with detailed notes, preserved from one conference to another, have found it of considerable assistance.

In my next paper I shall consider the question of intensification of output from its more technical side. The problem of new processes, the introduction of automatic machines, and considerations affecting the profitable introduction of specialised machinery will be first considered, and after this the larger problems of design as affected by the modern tendency to "manufacture" rather than "make."

In Mr. Slater Lewis's article in THE ENGINEERING MAGAZINE for October, foot of p. 61, "an additional 30 per cent." should read "an additional 70 per cent."

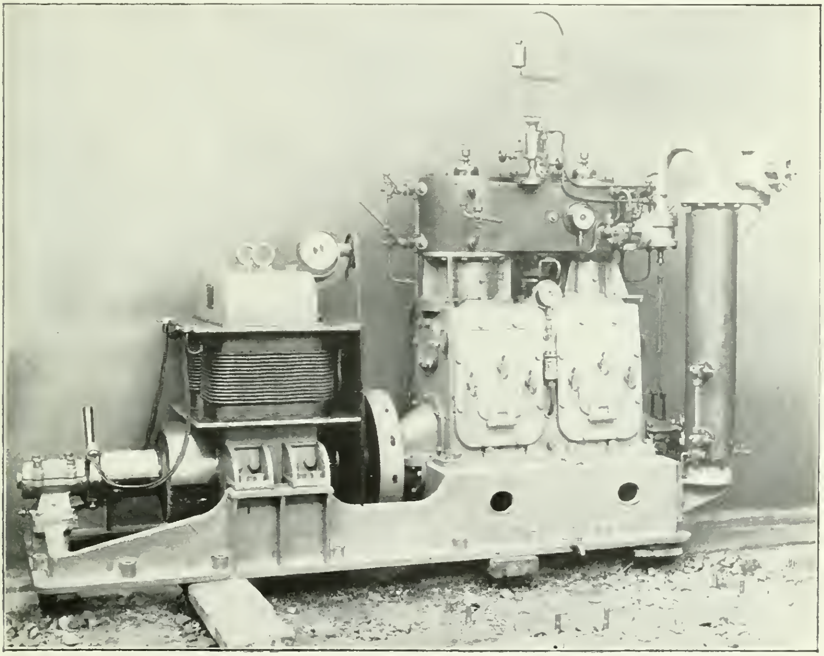
ELECTRICITY FOR THE OPERATION OF AUXILIARY MACHINERY ON WAR-SHIPS.

By Lieut. J. K. Robison.

THE article in the preceding issue of this Magazine stated, necessarily in an extremely concise way, the conditions of gross waste of steam in auxiliary machinery for war-ships, as they existed some five years ago, and the character of the efforts that have been made to reduce the losses in the auxiliary machinery, together with the degree of success of these efforts.

The good results obtained in central-station practice on shore, in the matter of steam economy in the generation of electricity, naturally lead one to suppose that similar results should be obtained on board ships. Unfortunately, tests which have so far been made of the steam consumption of dynamo engines, actually installed on ships by the furnishers of electrical supplies, show anything but a good economy. The steam used per indicated horse power has varied from 55 to considerably over 100 pounds per i.h.p. per hour. It is hoped that the latest and best type of dynamo engines, as furnished by the electrical manufacturers, may have a steam consumption not exceeding 30 pounds per i.h.p. per hour. Even this would not be particularly good; but, however disappointing the results thus far obtained from dynamo engines, the issue is not affected. Of course, it would never pay to extend the use of electricity if it be impossible to better the economies indicated above, but the study of the conditions by competent engine designers and builders is bound to lead to economical engines, even though the units be small. Progress in this particular, even if no other advance be made, will involve a considerable reduction in the amount of steam consumption by the auxiliary machinery. It will probably not be long before flat valves are used on low-pressure cylinders of the dynamo engines, and the gross waste from leakage which exists at present is bound to be materially reduced. The establishment of a central power station must certainly lead to an increase in the economy of steam consumption. The units as now installed in United States naval vessels are none of more than 50 K. W. capacity. I think it is fair to assume that, even for the light type of engine which is sure to be required on men-of-war, a steam consumption as low as 20 pounds per i.h.p. per hour can be obtained if the exhaust steam be taken to the condenser, and if the exhaust from the dynamo engines be taken to a feed heater the steam consumption should not rise above 26 pounds per i.h.p. per hour. In considering whether or not the exhaust from the generating engines of a central electric plant should be led direct to the condenser or to a feed heater, it is proper to consider the relative economy which would be achieved by the two systems. An increase of 30 per cent. in the steam consumption of the generating engines is pretty certain to follow their conversion to non-condensing engines. If the exhaust from the generating engines be taken to the feed heater, the gain in the total economy of operation of the entire machinery plant of the ship, as has already been stated, is about 9 per cent. The question, then, as to whether condensing or non-condensing engines should be used for the generating plant in the central station on board ship should depend upon whether or not 30 per cent. of the steam used by the generating plant is more or less than 9 per cent. of the total steam consumption. Of course, unless the system is very much worse than we have any reason to expect, it would pay to operate an auxiliary feed heater with the exhaust from the generating engines, which should be non-condensing.

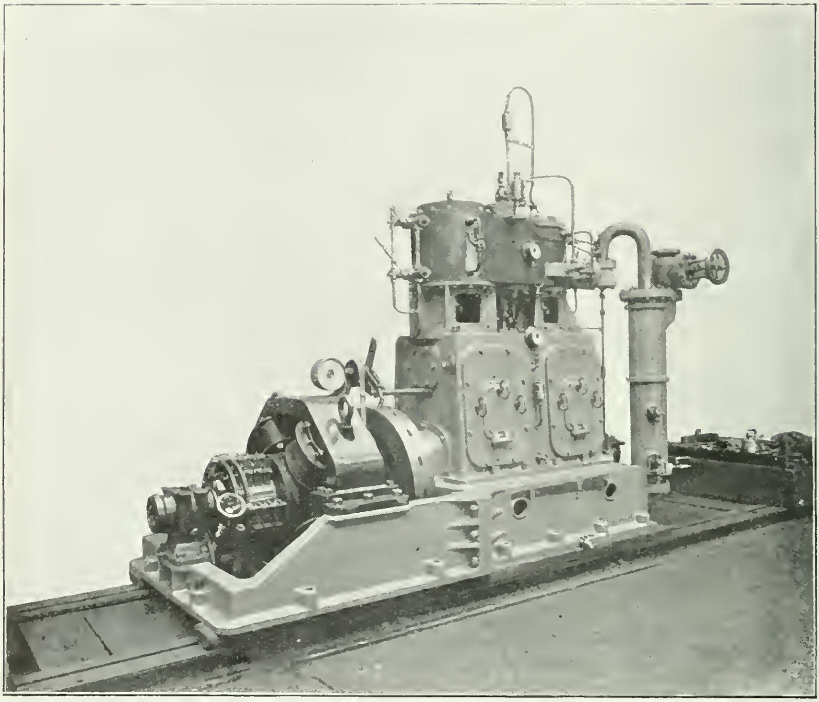
One point upon which the success or failure of electricity on shipboard depends is the economy of conversion of power from the steam engine driving the generating set to effective power on the motor shaft. This is a question which has been answered in a variety of ways. Upon the correct answer depends in large measure the success of an electric installation. Sylvanus Thompson has given figures averaging about 52 per cent., as the efficiency of conversion of mechanical work performed on the generator to mechanical work delivered by the motor. This with average line losses and fairly efficient electrical machinery operating under normal conditions. Experience in the navy has indicated that about 50 per cent. of the i.h.p. in the engine generators is transformed into useful work done by the motors. The experience of large commercial users of electricity shows that the efficiency of conversion of power varies from 40 to 60 per cent., depending largely upon the line losses. Mr. S. Dana Greene, of the General Electric Company, in a recent paper, has stated that the total efficiency of an electrical system on board ship may be as high as 65 or 66 per cent. I think it will be fair to assume an average efficiency of conversion equal to about 59 per cent., as follows: efficiency of generating engine, 93 per cent.; efficiency of generator, 86 per cent.; line efficiency, 95 per cent.; motor efficiency, 78 per cent. This assumes that the commutators are kept in good condition at all times. Experience in the navy shows that this will not be the case; but I believe that if electrical apparatus is installed on a large scale on men-of-war it will be properly attended to. It is assumed further that the efficiency of conversion of power from the motor shaft to the auxiliary machinery is the same for the electric motor as for the steam engine. In some cases, such as a centrifugal blower for example, this assumption is unfair to the electric motor. In other cases, such as a steam pump or an ice machine, the efficiency of a steam engine is considerably greater than that of the gearing attached to the electric motor. On the whole, I think the figure given, 59 per cent., not far from correct.



ENCLOSED TYPE OF COMPOUND ENGINE ATTACHED TO TWO-POLE DYNAMO.

The British Admiralty have lately adopted enclosed engines and dynamos, giving up the older type. The machine illustrated is by E. Scott & Mountain.

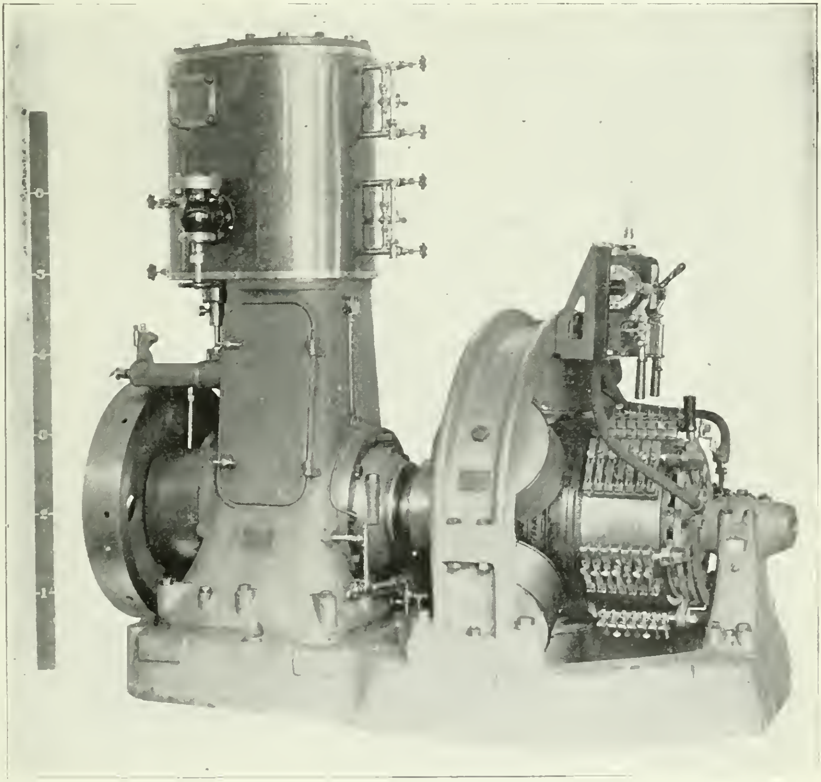
Probably the figures given above as to generator and motor



ENCLOSED COMPOUND ENGINE ATTACHED TO A FOUR-POLE DYNAMO.
Latest type of marine installation built for the Admiralty by E. Scott & Mountain.

efficiency will be considered low. I think, however, that when the large reserve of power required in the generator is taken into account, and when the variable loads and speeds of the motors are duly considered, the above figures will not be found to be too low. Roughly, it will take 5 i.h.p. in the engine driving the generating set to secure 3 h.p. on the motor shaft. If the steam consumption of the engine driving the generating set be taken at 26 pounds per i.h.p., the use of an electric installation would involve the equivalent of using about 44 pounds of steam per i.h.p. in the steam-operated auxiliary machinery. This is a reduction of 35 per cent. below the amount required by the most modern steam auxiliaries. If the auxiliaries now installed use 18 per cent. of the total steam, it would require but 12 per cent. to operate them by electricity.

This result is almost ideal. There will probably be considerably less condensation of steam in a central electric plant than there is among the widely scattered steam auxiliaries of a modern ship. While tests of the amount of exhaust steam at atmospheric pressure that can be usefully used in an evaporating plant or in a feed heater show that this may rise to 17 per cent., I think that the decrease in the amount of water of condensation in the exhaust steam from the electric engines may possibly decrease this figure to 15 per cent. On that account it seems to me that all of the gain of the electric system down to 15 per cent. should properly be credited to it, and that the use of electrically-operated auxiliary machinery will involve an increase of the potential value of each pound of coal on board a war-ship certainly of as much as 3 per cent. Further, the steam consumption of the electric auxiliaries has been shown to have been reduced to almost exactly that figure which will allow the condensation of all the exhaust steam from the generating engines in a feed-water heater. This is such a gain in simplicity that it is bound to lead to a gain in economy. At any rate, 40 per cent. of the difference between 12 per cent.

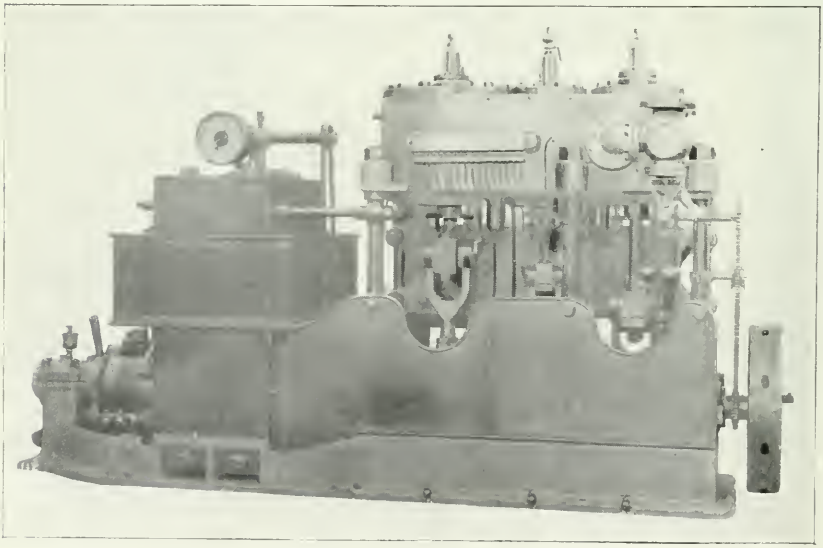


A NAVAL AUXILIARY GENERATING SET.

Made by the General Electric Company.

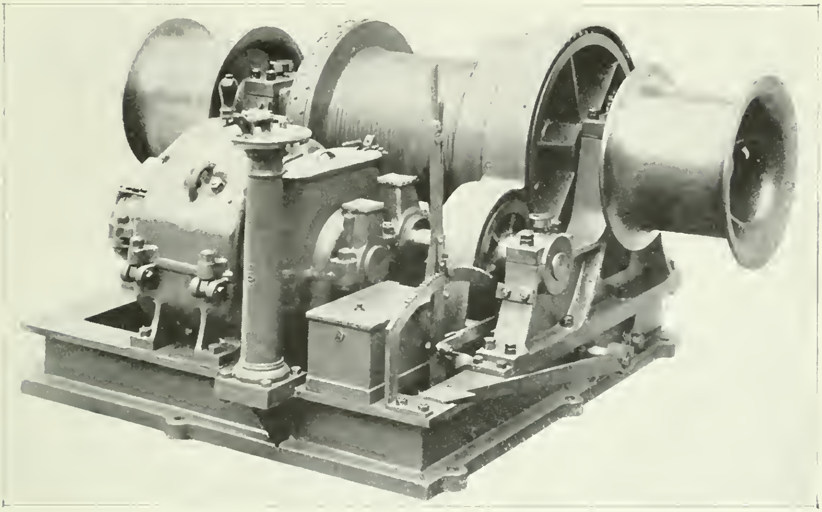
and 15 per cent. will be a saving, owing to the fact that more steam is used in the evaporating plant if the pressure be reduced to that of the auxiliary exhaust. The saving due to the use of electricity must then be 4.2 per cent. at least, with the possibility that this saving will be as great as 6 per cent., which is the maximum possible gain. It is proper to mention here that the above economy can only be attained if the electric generating engines are made of the most economical type, with a steam consumption when non-condensing not exceeding 26 pounds of steam per i.h.p. per hour.

Let us see if this is one of those apparent economies which are real losses. Does or does not the maximum possible gain of 6 per cent. following the introduction of electric auxiliaries, exceed the price we have to pay for it in increased weight? Unfortunately the increase in weight is considerably greater than the gain. Taking the case of large battle-ships of the latest type, the total power of the auxiliary machinery is at least 1,500 i.h.p. The approximate weight of this machinery is 150,000 pounds, or 100 pounds to the indicated horse power. If electric motors are used to drive the auxiliaries, it will be necessary, in order to get the requisite torque at the highest speeds, to install motors of 1.5 times the rated horse power that would be required if steam auxiliaries were used, thus requiring a total motor



OPEN TYPE ELECTRIC-LIGHT ENGINE AND DYNAMO

Supplied to Chilian battle-ship Blanco Encalada by E. Scott & Mountain



ELECTRIC-DRIVEN COMPOUND DECK WINCH.

25 h. p., 160 volts, 150 amperes, 320 r. p. m. Shunt wound. Made by the General Electric Co.

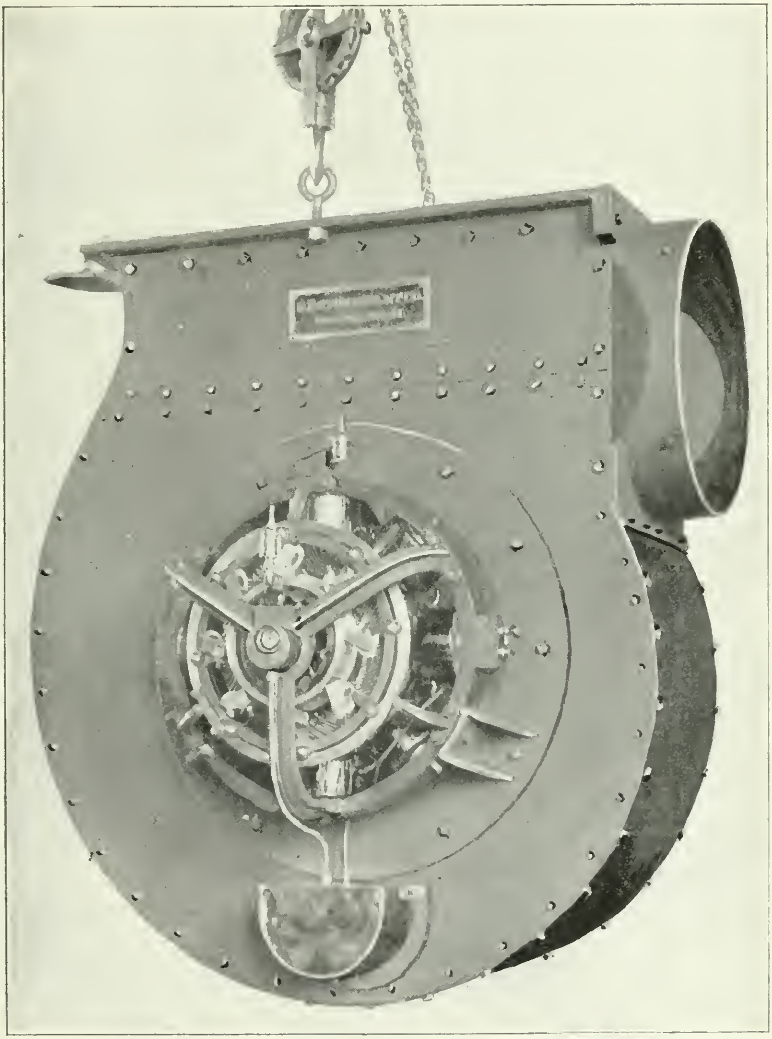
capacity of about 2,250 h.p. The weight of the motors per horse power may be taken as about that of the steam machinery. If the motors were large the weight would probably be less; but the motors required for the operation of the auxiliaries on board ship would generally be small ones. The increase in weight due to the use of electric motors will, therefore, be about 35 tons.

The principal increase in weight due to the use of electric auxiliaries is in the generating room, and here comes the question as to the amount of power required in the generating plant. While the total power of the auxiliary machinery on board a battle-ship is 1,500 h.p., the average power of the auxiliary machinery while the vessel is cruising at its most economical rate is only about 100 h.p., and the maximum power that is developed by the auxiliary machinery, which will be in time of battle with the vessel at full speed, is only about 700 h.p. This is because, during action, deck winches, anchor hoists, the ice machine, shop engine, and at least a part of the pumps will not be in use. Of course, all the forced-draft blowers, turret engines, ammunition hoists, steering engine, and a very large part of the pumps will be worked at full power. It may confidently be stated, however, that the maximum power of the auxiliaries will be about 700 h.p., with steam auxiliaries in use, or probably 1,000 if all the auxiliaries are electrically operated. The efficiency of the mechanical conversion of the power in the generating engines to effective power delivered at the motor shaft has been found to be about 59 per cent. The development of 1,000 h.p. by the electric motors involves, therefore, the development of about 1,600 h.p. by the generating engines. The central electric station should, therefore, be of sufficient capacity to develop this power upon demand. This requires, say, five 250-K. W. generators, four of which would be necessary for the production of the maximum current required and the fifth would be used as a spare. The weight of the electric plant of 1,250 K. W. capacity (both generating engines and generators proper, with wiring and piping, being included), would be about 180 tons. The total weight of the electric apparatus would, therefore, be about 295 tons, as against about 85 tons for the steam-operated auxiliaries with their piping and connections. That is, the installation of a central electric station would involve multiplying the weight of the auxiliary system by 3½, if the generating plant be made of sufficient size to be capable of satisfying the maximum demand and if one spare unit be installed.

Some calculations as to the weight of the generating plant give lower figures than the foregoing for the weight of the electrical apparatus required. Mr. Dana Greene says that it would require only 2½ to 3 times as much weight as that of a steam plant. His figures are based upon the following assumptions: (1). There will be no increase in the weight of the motors beyond that of the steam engines now used as auxiliaries; (2). The efficiency of the mechanical conversion of power is taken at 66 2-3 per cent.; (3). The total size of the generating plant is taken at 1,050 K. W.'s, divided into units of 150 K. W.'s each.

It seems to me that the weight of the electric installation would be much more nearly 4 times than 2½ times as much as that of a steam system. If my premises are correct, the use of electrical installation involves an increase in weight of 210 tons. If the calculations of the more enthusiastic advocates of the electric system are correct, the use of electrically-operated auxiliary machinery involves a difference of but about 150 tons in the weight of the auxiliaries. In either case, the bunker capacity of our largest ships being 2,000 tons, the additional weight is considerably greater than the greatest possible gain of 6 per cent. One hundred and fifty tons is 7½ per cent. of the bunker capacity, while 210 tons is 10½ per cent. To increase the potential value of a ton of coal by 6 per cent., we will have to decrease the amount of coal by as much as 10 per cent. The net result is, of course, disadvantageous as respects the steaming radius of the ship.

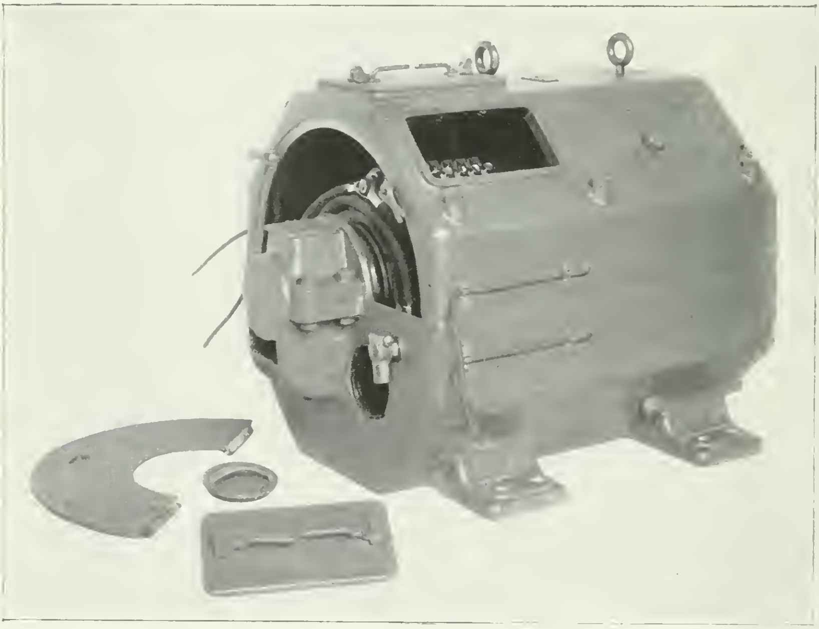
Therefore, inasmuch as the steaming radius is a vital factor, the introduction of an electric central station for the operation of all the auxiliaries of war-ships does not seem to me to be advisable. The use of the best electric apparatus for operating the auxiliary machinery involves a loss of about 5 per cent. in the ship's radius of action. Indeed, the above conclusion follows the use of electric apparatus considerably better than any that has yet been fitted in a ship. A loss in



ELECTRIC-DRIVEN STURTEVANT FAN FOR SHIP VENTILATION.

coal endurance follows also the adoption of the premises of the most ardent advocates of the electric system. Electric auxiliaries cannot, therefore, pay until considerable progress has been made in the design of electric apparatus.

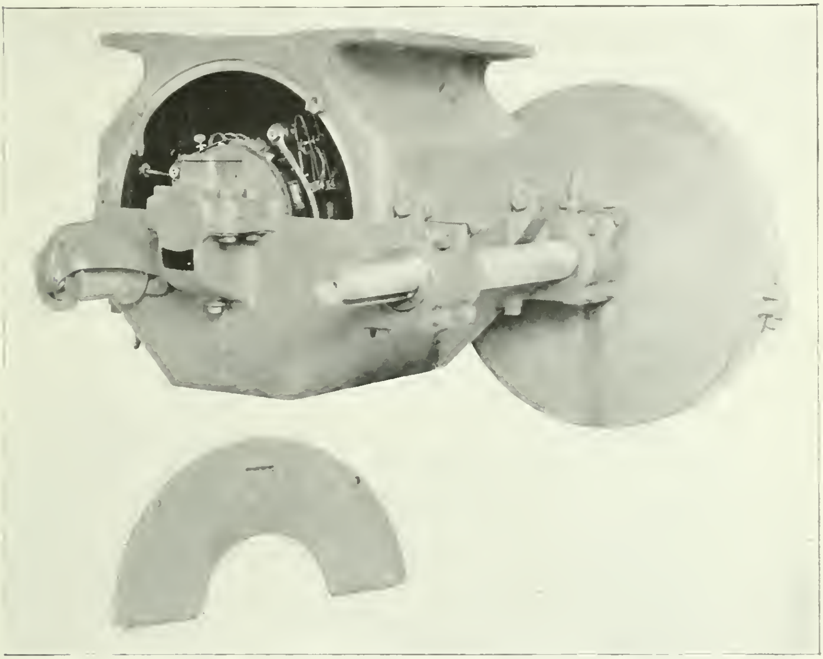
The enormous value of coal endurance is shown in such instances as that of the "Newark," disabled completely 300 miles north of the Straits of Magellan for lack of sufficient coal to complete the 2,500-mile passage between Montevideo and Valparaiso. Ships are nearly always able to complete any trip they commence, and coaling stations are not generally far apart along any of the usually traveled lines of commerce. It was not very many years ago, however, that the steamer "Rio de Janeiro" was forced to turn back on her 3,500-mile trip between Honolulu and Yokohama. In this case the "Rio" only got back to port after burning some of the wooden fittings of her cabins. These failures serve very well to point the importance of a large coal capacity for all ships, and particularly for men-of-war. In time of war a large number of coaling ports are closed to the belligerents and, by many nations at least, coal is declared contraband of war.



ELECTRIC TURRET-TURNING MOTOR.

50 h. p., 80 volts, 500 amperes, 400 r. p. m. Shunt wound. Made by the General Electric Co.

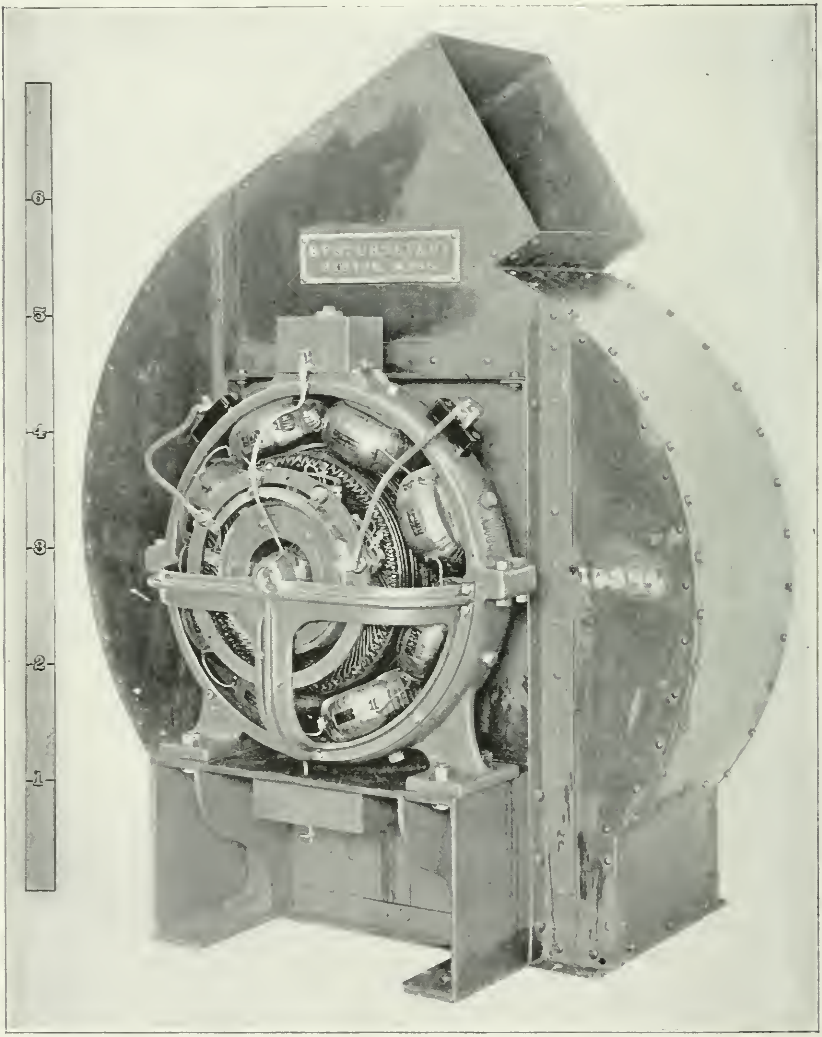
To justify the general use of electrically-operated auxiliaries on board ship, certain specific progress must be made in design. Probably satisfactory steering engines or anchor hoists have not yet been evolved, yet they certainly can be made and will be made as soon as it becomes necessary. I believe that the installation of electric machinery is carried considerably further on the Russian battle-ships building at the Cramps' than has yet been attempted in any American ship. It will be interesting to note the operation of this machinery in service. Elecrically-operated auxiliaries can readily be made of sufficient power not to be put out of order easily, and I think can be made to satisfy all the requirements of naval service. This involves some progress beyond the present position attained by the designer of electric motors. The auxiliary machinery aboard ship works with such a wide range of power and speed that electric motors, as at present designed, are not very efficient for average conditions.



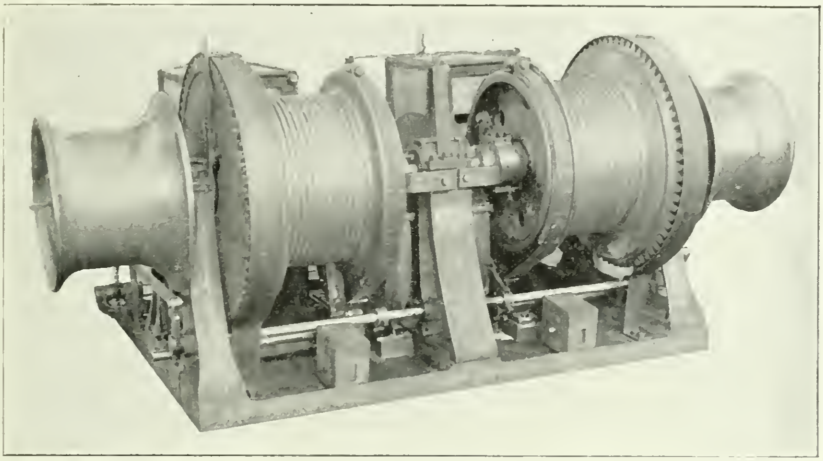
AN AMMUNITION-HOIST MOTOR.

20 h. p., 160 volts, 110 amperes, 350 r. p. m. Shunt wound. Made by the General Electric Co.

It would be a vast advantage if electric motors could be lightened; but the great loss involved in the use of electricity comes in the generating room. The principal advance that we may expect will probably be the adoption of an efficient turbine engine which will maintain a high rate of efficiency over a wide range of power. This will probably involve a decrease in the amount of steam used by the generating engines, and in that respect an increase in economy for the use of electricity. Further and chiefly, the adoption of turbine engines will reduce the weight of a generating set by, it is hoped, 40 to 50 per cent.

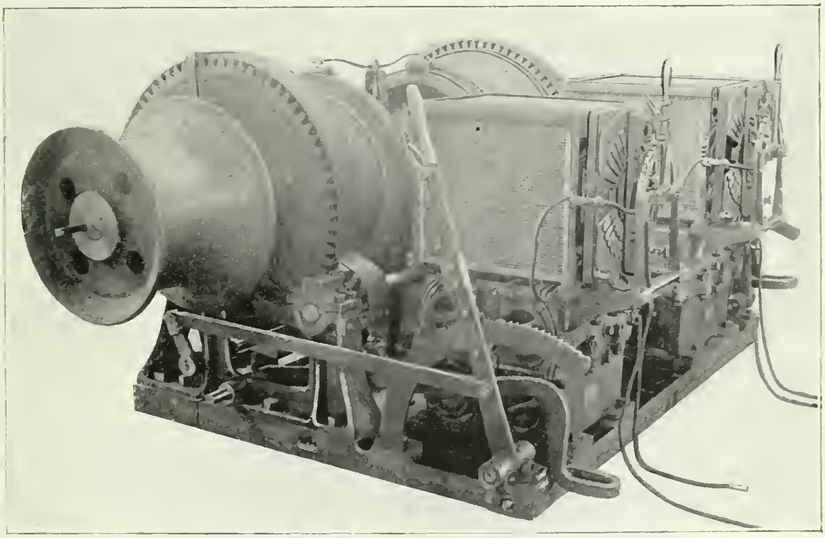


ELECTRIC MOTOR DIRECT-CONNECTED TO 50-INCH EXHAUSTER.
Made by the General Electric Co.



DOUBLE ELECTRICAL STEAM-SHIP HOIST FOR THE NORTH GERMAN LLOYD.

We may also confidently look forward to an increase in the efficiency of conversion of mechanical power. The efficiency of motors especially is being increased until to-day it has reached a figure that it would have been thought unreasonable to expect ten years ago. I think that we may hope for an increase in efficiency of conver-



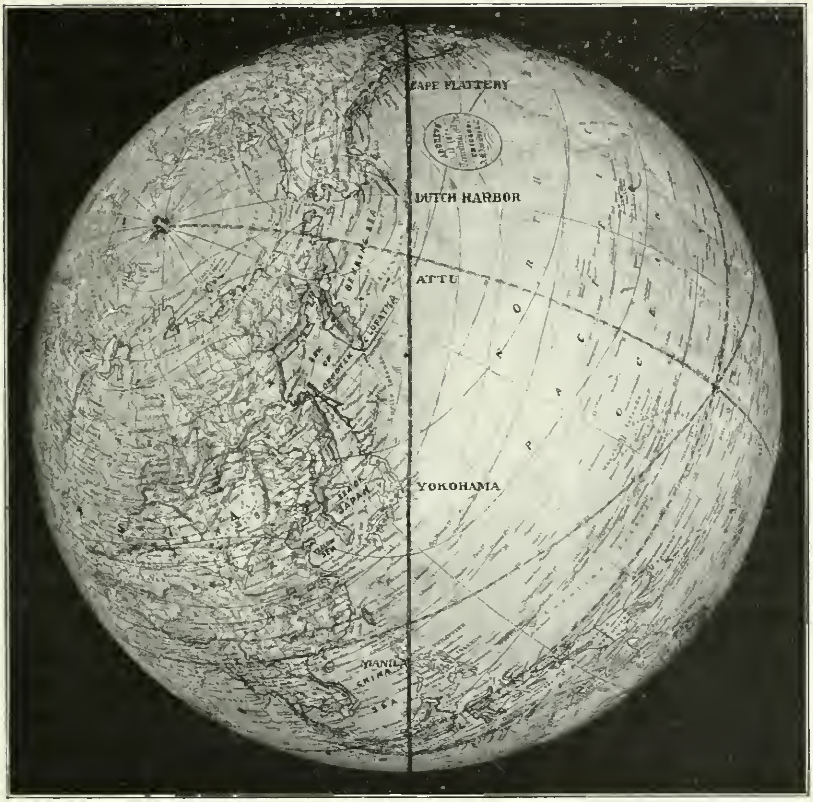
DOUBLE ELECTRICAL STEAM-SHIP HOIST.

Built for the North German Lloyd by the American Ship Windlass Co. Driven by two motors of 26 h. p. (actual) each. Can raise on each drum 2 240 lbs. at rate of 207 ft. per minute, or 6,720 lbs. at rate of 69 ft. per minute. Weighs 11 500 lbs.

sion of energy to, perhaps, as much as 70 per cent. If this can be achieved, and if the turbine engine is properly developed so as to be available for naval use, the adoption of electrically-operated auxiliary machinery would not involve an increase in weight exceeding 100 tons. The added weight will not then have so bad an effect upon the coal endurance, while the change to electrically-operated machinery may have such a beneficial effect upon the efficiency of the ship's auxiliaries, and of course upon the ship itself, that we may expect its adoption. Of course, it is more than possible that, by the time the electrical men offer a feasible solution to the problem, the manufacturers of the steam auxiliaries may have cut their consumption down to such a low figure as to eliminate all the gain due to the electric system. Prof. Elihu Thomson has shown us that it is possible to operate very small steam engines with a steam consumption less than 30 pounds per i.h.p. per hour. On the other hand advance in the design of auxiliaries may very possibly be made by the mechanical engineers themselves in, for instance, the form of a feed heater which will take steam from the receiver of the engine. If this can be properly developed, it will pay to use condensing engines for the generating sets and the consumption of the auxiliaries can be profitably reduced to a minimum.

I have given some reasons why it seems advisable to increase the size of the electric generating units. There are some reasons why this is difficult to accomplish, such as the difficulty of control of the turret machinery when not operated, as at present, by a separate generator for each turret. This progress in design must certainly come, however, before we can use electricity in a general way.

The whole question is one of economy. To-day electricity takes more than it returns, and that is why we are not justified in extending the use of electricity until the weights can be cut down materially.



A great circle—the shortest possible route across the Pacific.

THE PROPOSED PACIFIC CABLES.

By Harrington Emerson.

OCEAN cables are commercial enterprises to facilitate communication between friendly countries. Every one of the sixteen North Atlantic cables was laid to this end. It is folly to make an improbable war the governing condition for a new cable, but, as there is a disposition on both sides of the Atlantic to subordinate the prosaic and immense interests of peace to martial pomp, however remote, it may be worth while to point out that cables to neutral countries are much safer lines of communication in time of war than national lines. Notwithstanding strenuous efforts, the United States were not able to interrupt cable communication with Cuba, because there were several cables to neutral shores, but Dewey found no diffi-

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The rapidly advancing development of the Far East demands the speedy completion of the world's electrical girdle. England's road to China across her vast North American culty in severing the Manila cable. If Great Britain should become involved in a European war and all her several lines to India be cut, is it supposable that island specks in the Pacific could be defended against marauding cable cutters? In time of war a national cable becomes at once, in its whole length, so much more frontier exceedingly vulnerable and impossible to defend against the most insignificant enemy.

The real prize in sight for a Trans-Pacific cable is not the transmission of war despatches, but the Asiatic business which shall be briefly considered in comparison to European trade, in its actual volume and in its prospective growth.

The foreign trade of the United States with Europe, facilitated by thirteen cables and several more building, is about $1,200,000,000 annually. The total foreign commerce of Asia amounts to $2,000,000,000 and it is helped by three cables from Bombay via Aden, one Persian Gulf line via Asia Minor, and one Russian overland route.

The north-eastern Asiatic trade amounts to $656,000,000, of which the United States in 1897 had secured $112,000,000, or about one-sixth. This business, with the densest population in the world back of it, is as naturally tributary to the United States and Canada as the trade of the Hawaiian Islands is tributary to San Francisco, which has secured 99.79 per cent. of the exports from, and 76.27 per cent. of the imports into, the islands. The possession of the Philippines by the United States, the development of Japan, the awakening or partition of China, the completion of the Siberian Railroad (which will be finished in two years), will enlarge the trade of Asia to a volume commensurate with population and North America should secure most of it. Mr. Herbert H. D. Peirce, first secretary of the United States embassy to Russia calls this latter country, as opened by the new railroad, an immense field far beyond anything realized by Americans for the introduction of machinery and for an unlimited market of manufactured goods. Mr. John Barrett, formerly United States Minister to Siam, who has made a special study of Asiatic trade gives the single island of Java, which is but little larger than the state of New York, an annual foreign trade of $250,000,000; yet Java has only half the extent of fertile areas credited to the Philippines. He gives to Hong Kong in 1897 a total also of $250,000,000,

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colonies, and America's route to her new Pacific possessions, must be paralleled by a Trans-Pacific cable. But it must be a practicable, commercially valuable line—not a national fetich. Mr. Emerson is finishing a thorough study of the entire question, in which he has had invaluable aid and exceptional facilities afforded by officials and by the great telegraph companies. His conclusions, imparted in this paper, are of particular interest and importance at this juncture to the English speaking world on both sides of the Atlantic. THE EDITORS.

and to Singapore $180,000,000, and for the Asiatic coast from Singapore to Vladivostok the mighty sum of one billion dollars and yet, he adds, the foreign trade of this wonderful Pacific Asiatic coast line is only in the earliest stages of its development.

Elsewhere, urging the laying of a Pacific cable, he says that the tremendous monopoly of the present telegraphic connection between the far east and America is a great handicap to the development of trade with the United States, and that he has frequently heard merchants of all nations in Asiatic ports say that the cost, time, and difficulties of cable connection with the United States works against the extension of American commerce.

With cable connection, Mr. Barrett estimates the probable increase of Philippine trade alone in the next fifteen years at 300 per cent. It is therefore within reason to estimate the growth of all the Asiatic trade at 50 per cent. in the next ten years, and if the proportion obtained by North America becomes 25 per cent. of the whole, there would be an increase in American business to $600,000,000. This is a prize in the telegraph field that is worth securing by being first in the field, obtaining as many privileges and connections as possible, and reaping for years all the benefits of non-competitive business.

An unbiased review of the different proposed telegraph routes from North America to Asia excludes consideration of private promoting and constructive interests. A cable might be laid on a line that is commercially impossible, a fact which would not necessarily deter those who expect to furnish the material for, or to profit by the laying of, the line from advocating it, especially if governments can be induced to grant subsidies which would more than meet the whole interest charge and cost of maintenance.

Deep-sea and long cable laying are not untried experiments; the deepest cable laid is the short stretch from Haiti to the Windward Islands, in three thousand fathoms, and the longest cable is the French line from Brest to Cape Cod, 3,110 sea miles, which includes the usual allowance of 10 per cent. for slack. A short deep cable is not a serious problem, nor is a long cable in medium depths; but the combination of extreme length and depth adds very much to the hazard and difficulty of any cable undertaking.

Unless a heavy copper core is used, long cables are so slow as to be almost valueless commercially; but a heavy copper core means heavy insulation and heavy sheathing, resulting in a costly cable, difficult to lay in deep water and troublesome to repair. The core of the long French cable is made up of thirteen copper wires of different gauges, weighing 660 lbs. per mile; it is insulated with 396 lbs. of gutta percha per mile. The total weight is 10,000 tons. The standard core for submarine cables under 1,000 miles in length is 107 lbs. of copper per mile.

The difference in cost between long cables in deep seas far away, and short cables in shallow seas near manufacturing centers, is shown by the comparison of the contract price for the Denmark-Iceland cable, and the estimates of the British Commission for the proposed British-Pacific cable. The distance from Denmark to Iceland, with a landing on Scotland, is 900 miles and the route lies through shallow northern oceans. The contract price is 450,000 Kroners,* $134 or £27, 10s. per mile. The Althing of Iceland contributes 150,000 Kroners and the Great Northern Telegraph Company, of Copenhagen, the balance of 350,000 Kroners. The estimate for the Vancouver-New Zealand cable—a distance of 7,986 n. miles with one long stretch of 3,561 miles—is £2,000,000, equalling £250 or $1,220 per mile. In the one case a mere filament of copper and insulation is used, which is cheaply laid by a small steamer; in the other case, the minimum proposed by Lord Kelvin is 552 lbs. of copper and 368 lbs. of gutta percha per mile. It is not a small item of expense to fit up a cable steamer that can carry 10,000 tons of cable and the necessary coal for a 3,500 mile trip. The annual maintenance cost of this long cable, exclusive of operating expense, is put at $350,000 annually. Owing to its one long stretch of 3,561 miles, this cable costs per mile nearly ten times as much as the 900 mile Icelandic cable in two stretches. These are extreme examples, one, the cheapest long cable in the world; the other, the most expensive.

Several projects subserving private rather than public interests have been promulgated on both sides of the Atlantic, and specious arguments have been advanced in favor of exclusive national lines. The arguments, however weak, are offered in the hope of creating an uncritical enthusiasm on the wave of which some government can be induced to vote financial support.

The ideal Trans-Pacific route is the one promising:

1. To secure the largest amount of present business.
2. To develop the largest amount of new business.
3. To cost the least money to lay.
4. To be laid and maintained most easily and cheaply.
5. To be operated most rapidly and with least interruption.
6. To be politically most valuable.

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* The Kroner is equal to 26.8 cents, or about 13 1-2d.

A legitimate cable enterprise across the Pacific is not one depending on government subsidies as the only protection against bankruptcy, but one in which commercial and government business will pay both maintenance and interest.

Four Pacific routes have been proposed, and the arguments in favor of each will now be considered by these tests—commercial, financial, physical, electrical, and political—and thus an unbiased conclusion be reached as to which is preferable. Of the four proposed routes one is British (running, not across the Pacific, but north and south through it), one American, and two are international.

Owing to its length, cost, and difficulty, the British cable from Vancouver, B. C., to New Zealand easily ranks first as an ambitious project. Its length is 7,986 nautical miles. The American route, which is proposed from San Francisco to the Philippine Islands, via Hawaii, is 6,640 miles. The shortest of all the routes is the international route of 3,687 n. miles via the Pacific coast of North America to connection with Asiatic lines, and the fourth route is an international overland route via the Yukon River and by short cables to Asia, a revival of the old Western Union overland route to Siberia.

THE BRITISH CABLE.

Vancouver to Fanning Island.......	3,561	Nautical Miles.
Fanning Island to Fiji.............	2,093	"
Fiji to Norfolk Island.............	961	"
Norfolk Island to New Zealand.....	537	"
	7,152	"
Branch from Norfolk Island to Queensland..................	834	"
Total	7,986	Nautical Miles.

A fact not brought to the attention of the commission is that the long stretch can be shortened a few miles by laying from the north end rather than from the south end of Vancouver Island.

In considering the probable volume of paying business for any cable, the way stations, terminals, and the world beyond the terminals must all be taken into account. In this British cable the way stations are insignificant. Fanning Island, inhabited by a dozen persons, is a small coral reef in the Pacific Ocean, about 1,000 miles south from Honolulu. The Fiji Islands and Norfolk Island are not important, the former having a population of 110,000. The terminals—British Columbia and New Zealand, both magnificent colonies—are very similar. Both lie in the temperate zone, are mountainous, sea-girt, sparsely and recently settled; the chief products of both are wheat, lumber, fish, and minerals, and, owing to this similarity, no very great interchange of products either exists or is from the nature of the case to be expected.

The great volume of business must come from the commercial world beyond the terminals—North America and Europe on the one side, the whole of Australasia, India, southern and eastern Asia, on the other; but it is at least questionable whether much of this world business would be diverted to this circuitous route. Competing lines via southern Europe are much shorter from London to India and Japan, shorter even from London to New Zealand, and these lines not only have their business well established, but will lower their tariffs to retain it. It is also to be apprehended that the construction of a direct line between North America and northern Asia will take the larger part of all commercial business; for who would cable from Vancouver to Japan or China, via New Zealand, if he could reach these points in one-third the distance and time?

The All-British cable certainly does not follow established trade routes, and this objection was made to it by Mr. Lucas before the British commission. It is not a route that can secure the greatest amount of paying business. This is not, however, the only nor the most serious objection. The first stretch of 3,561 miles, from Vancouver to Fanning Island is 450 miles longer than any cable yet laid, and this extreme length makes this line very costly to build. The difficulties of laying the cable will be greater than hitherto experienced, because it is longer and heavier and because the sea is deeper, even to 3,000 fathoms for hundreds of miles at a stretch, with possible holes of greater depth. A known hole of 5,515 fathoms (not on the route) was brought to the attention of the British commission, as a warning of a contingency to be met almost anywhere in the south Pacific.

It is on account of this depth and length that the cost of maintenance is put at £70,000 per annum and of operation at £22,000 per annum. A business of 750,000 words per annum at 75c. or 3s. a word (three times the Atlantic rate) is estimated in order to earn gross £178,000, and even this sum is less than 4½ per cent. net on the first cost.

Wires of 650 lbs. of copper per mile, or 96 lbs. more than proposed for a distance of 3,561 n. m., have a maximum theoretical speed

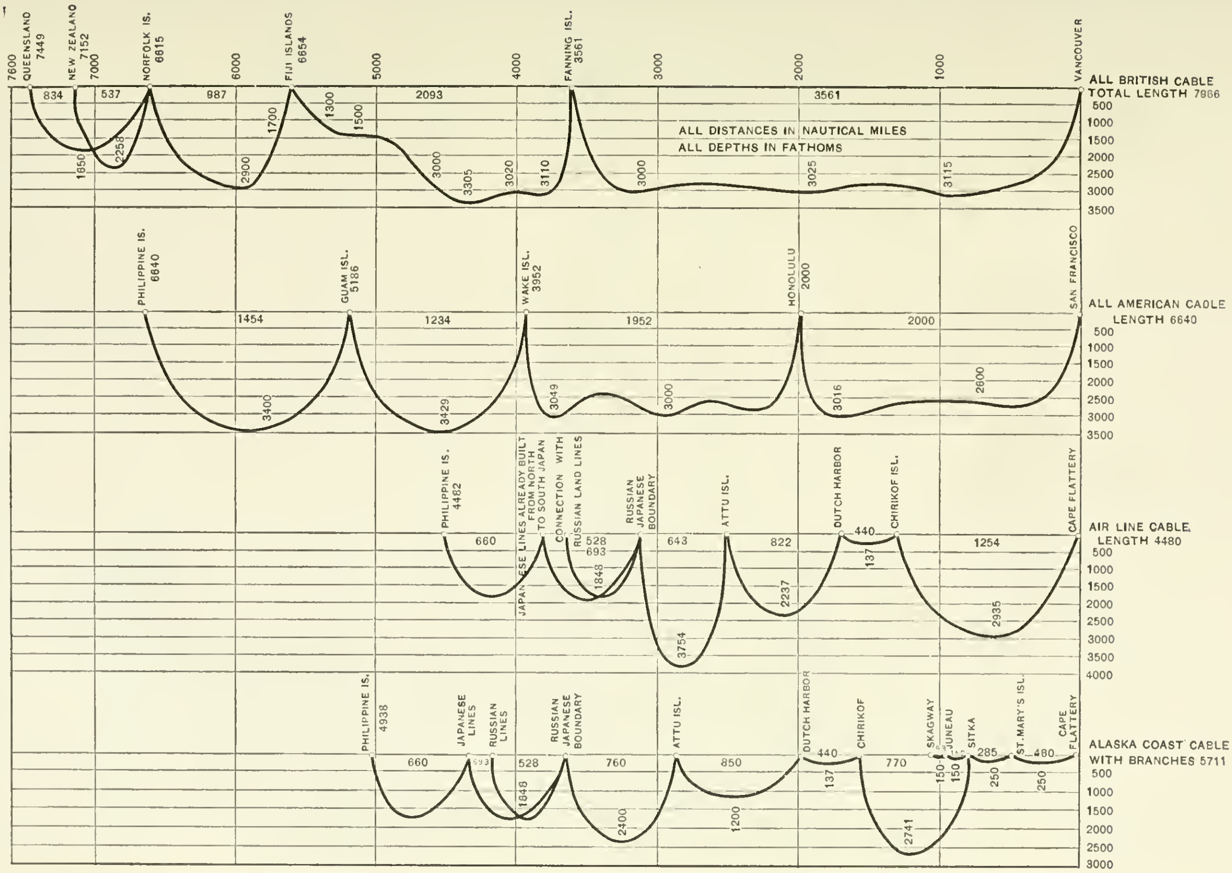

DIAGRAM SHOWING COMPARATIVE LENGTHS, DEPTHS, AND SPANS OF PROPOSED PACIFIC CABLES.

of sixty to ninety words a minute, and the various experts reduce this to practical speed of paying business of from four to forty words per minute. This wide variation in estimate emphasizes the uncertainty of this experiment. This long north-and-south cable would, however, be free from the magnetic disturbances that are liable to cause trouble on northern land or sea lines.

So unpromising is this cable from a commercial point of view that it is advocated solely on sentimental grounds. It is called the "All-British" cable because it touches only British possessions. Its promoters deplore that Bird Island, 150 miles west, northwest of Kauai, and only 2,600 miles from Vancouver, is not a British possession. That it is not is because the vessel despatched to annex it as an unclaimed island arrived too late, the Hawaiian flag having been raised the preceeding day. Now, notwithstanding an offer, a landing on Hawaii is distinctly rejected, because, in spite of the additional business from Hawaii, a station on foreign soil would at once deprive this cable project of the only argument with which it can be defended, namely that it is All-British.

Because it can never be made to pay commercially, the mother-land and all the colonies which this line touches are asked to contribute the capital required to build it, and its promoters refuse to consider an annual subsidy of £20,000 a sufficient guarantee to induce private capital to subscribe to the undertaking.

THE AMERICAN CABLE VIA HAWAII.

This route, as originally proposed, ran from San Francisco to Hawaii and thence to Japan, a rational and sensible route, yet a thousand nautical miles longer than from San Francisco to Yokohama, via the northern route. Recently, owing to the expansion fervor, its American advocates have copied in a weak and diluted way the British arguments and now suggest an "All-American" cable to the Philippines.

The stations are:

San Francisco to Hawaii	2,000	Nautical Miles.
Hawaii to Wake Island	1,952	"
Wake Island to Guam	1,234	"
Guam to Philippines	1,454	"
Total	6,640	Nautical Miles.

It has been openly charged that any cable reaching Hawaii will stop there, and the selection of Wake Island as the next landing place gives weight to this charge. Wake Island is a very small uninhabited coral reef thus described by Chas. Wilkes, U. S. N., who visited it in 1841. "Wake Island is a low coral one of triangular form, eight feet above surface. There is no fresh water on the island and neither pandanus nor cocoanut trees. The rise and fall of the tide was three feet. From appearances the island must be at times submerged or the sea makes a complete break over it; the appearance of the coral blocks and of all the vegetation leads to the conclusion, showing also that the violent winds or rush of the water when the island is covered are from the westward." *

Wilkes' survey of this island was corrected in 1898, with the remark that the island is from five to fifteen feet above high tide with rise of tide about six feet. The last reports on the island are dated January 17, 1899, on which date observations were made by the U. S. S. Bennington, with the following remarks: "No anchorage. Entrance to lagoon closed. Island is in some places twenty feet above water. Nothing was seen to indicate that the sea breaks over it." In view of the fact that the barometric wave is eight feet, that the tidal wave following earthquakes is often forty feet, that storm waves in those vast reaches of the Pacific may be very high—it seems impossible that this island should not be frequently submerged, and while it has been suggested that a high tower could be built in which to land the cable and in which the cable operator might find refuge, the same authority also insisted that a ship should visit the island every few months and replace the employees, who by that time would probably be insane and playing havoc with the messages.

If the uninhabitable Wake Island is discarded as a cable landing, the stretch between Hawaii and Guam becomes 3,186 miles, and this is only slightly less objectionable in expense, difficulty, and uncertainty than the Vancouver-Fanning stretch of the All-British cable. Four surveys have been made from California to Hawaii. The depth found on all of these is from 2,500 fathoms up to 31,000 fathoms. Two surveys have been made west of Hawaii, and on one the depth reaches 3,287, and on the other 3,409 fathoms. A few miles southwest of Guam, the sounding is 4,475 fathoms, and, while this hole can be avoided, depths of 3,400 fathoms between Guam and the Philippines must be reckoned with.

It is highly desirable for the United States to have more direct cable connections with the Philippines than 14,000 miles, via Europe,

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* United States Exploring Expedition. V. 5, pp. 267-268, Charles Wilkes, U. S. N., 1845, 5 vols.

and it is also highly desirable to connect Hawaii with the United States by cable; but this latter project should be considered on its own merits and, even if a heavy cable were now in operation to Hawaii, it would still not be a way station on a direct Asiatic line. All the Hawaiian business can be safely handled over a thin, and therefore cheap, cable. The Hawaiian Islands have a total population of 109,000, nearly all Asiatic coolies. The business is principally with San Francisco and in the hands of a very few firms, mostly American. No cable can greatly increase American trade with the islands.

This cable via Hawaii, not even the shortest route to the Philippines, owing to the length of its links, the enormous sea depths, the ocean wastes, is scarcely less to be condemned than the All-British cable. It can never be built without a subsidy that must amount to a guarantee of a substantial rate of interest on its entire cost, because the volume of commercial business over it will always be small. Its cost is estimated by Z. S. Spalding, president of the Pacific Cable Company, of New Jersey, at $10,000,000, and the cost of a cable to Japan, via Hawaii, is estimated by Jas. A. Scrymser, president of the Pacific Cable Company, of New York, at $7,000,000 or $1,034 per mile.

It is not generally known that the nearest point in the United States to the Philippines is Cape Flattery, the northwest corner of the State of Washington, from which point the distance by air line or great circle, all the way to the Philippines, is 5,400 miles—700 miles less than from California, via Hawaii.

All the Atlantic cables follow great circles as closely as conditions will permit, but the two new Atlantic cables will diverge from this short course and be laid far to the south via the Azores, because there is no other way in which the long single stretch from Ireland to Newfoundland can be broken into two shorter links, and, notwithstanding the increased cost and greater aggregate length, there will be gain in speed and economy.

The western cable builder is more fortunate than his Atlantic forerunner, because in the Pacific the short great-circle route is also the route of shortest links. It does not run through the wastes of the Pacific, but follows closely the British and United States north Pacific coast, which is so rapidly growing in importance, runs through Dutch Harbor in Alaska, touches Attu, the last of the Aleutian Islands and until recently the most westward possession of the United States, crosses in short links to the Russian-Japanese boundary, with one branch to connect with the existing Siberian net-work of land lines, and the other branch to run down through Japan (Yokohama being on the air line), and onwards to the Philippines, looping, on its way from Attu to Manila, the whole of the rich Asiatic coast to North America.

THE GREAT CIRCLE CABLE.

Cape Flattery to Chirikof Island	1,254	Nautical Miles.
Chirikof Island to Attu, via Dutch Harbor	1,262	“
Attu to Russian-Japanese boundary	643	“
Boundary to connection with Siberian land wires	528	“
Minimum of mileage to connect with all Asia	3,687	“
Cable from boundary to Japanese land lines	693	“
Cable from Japanese lines to Philippines	600	“
Total	5,040	Nautical Miles.

This system gives two wholly independent lines from Russian-Japanese boundary to the Philippines—one line via Vladivostok, Pekin and Hong Kong, and the other via the Japanese lines. To interrupt Asiatic communication, the United States would have to be at war with both Russia and Japan, or with Great Britain and Japan. In the former case, communication is still open as at present via Europe, and in the latter case danger on both Atlantic and Pacific coasts would be so great as to make communication with the Philippines a secondary matter.

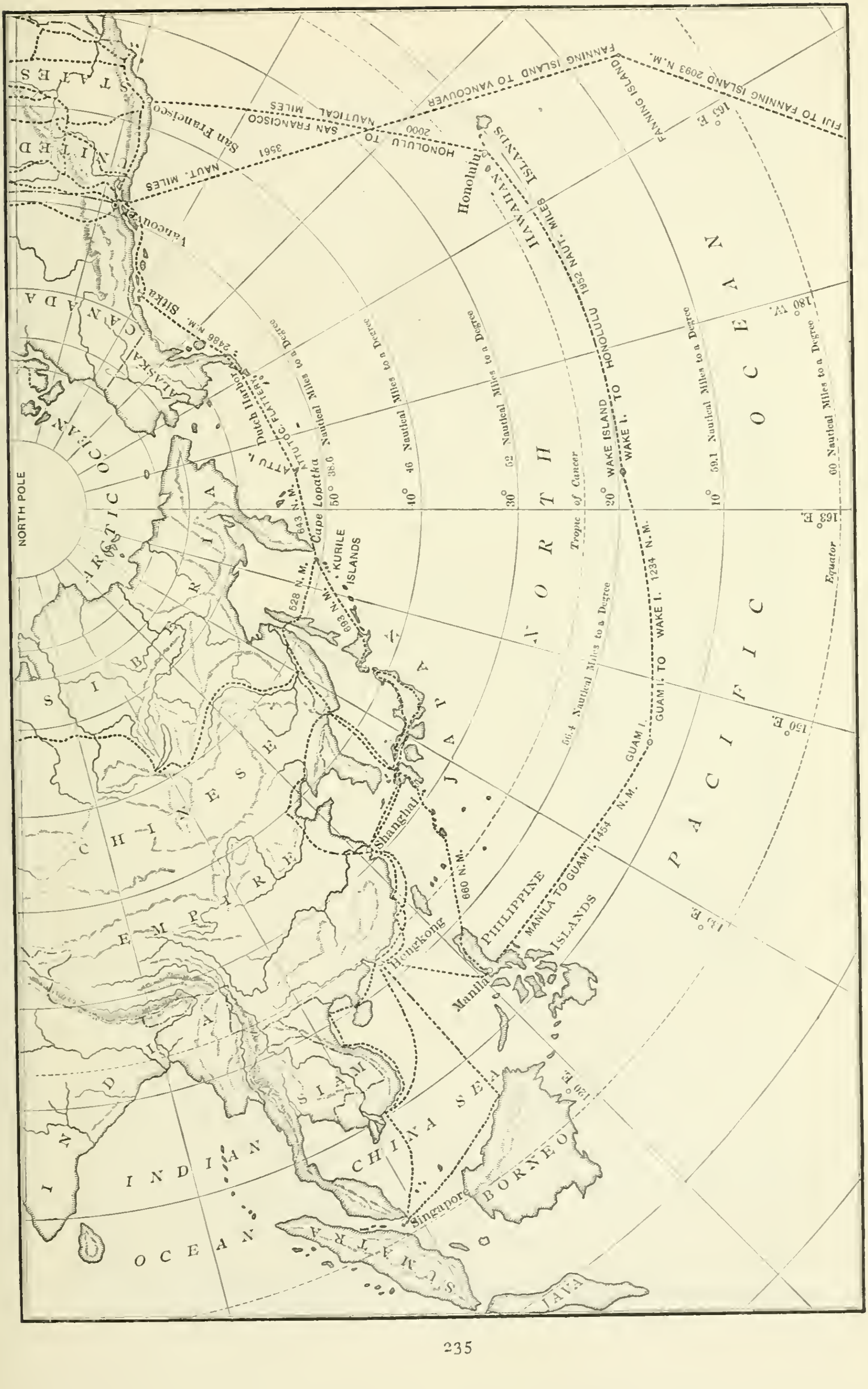
Stretches of over 1,200 miles are given in the table, but the longest necessary link is 528 miles. Everywhere else this cable lies so close to land as to permit intermediate stations, whenever desirable. This makes it possible to use the Morse instrument, thus adding very greatly to the speed of transmission. It would be no serious matter to add a few miles to the length of these short shore lines and to run via Mary's Island, Sitka, and Cook's Inlet, with a branch to Juneau and Skagway, thus bringing the whole Alaskan coast into cable communication with the United States. This is a necessity which sooner or later must be met, and only those who have been in Alaska know the millions of dollars and the hundreds of lives such a line would have saved, had it been in operation during the last two years.

In the joy over the new island possessions with their Asiatic inhabitants, the United States should not forget that all the Philippines are only one-fifth the size of the enormous Alaska, to which there has been a rush of 30,000 of their citizens in the last two years.

Not the least important service of a cable, via Alaska, would be daily meteorological reports to the weather bureau from Dutch Harbor, Attu, Bering Island and Choumchoum Island—reports of incalculable value in all weather predictions for the whole United States; if this route had no way stations and led nowhere, its meteorological importance alone would justify a heavy expenditure of money. It will, however, be subjected to the same tests applied to the other proposed routes.

The way stations of importance are Juneau, Skagway, and Dutch Harbor. All the Alaska and Yukon business to the gold regions goes either by way of Juneau and Skagway, or by way of Dutch Harbor, and this business in and out amounts to $40,000,000 annually and is steadily increasing. It is in the hands of at least ten thousand active men, and, owing to the impossibility of mail transmission during many months in the year, there must be much cable business. The shipping and passenger interests are very great and steamers arrive at Skagway from the south almost daily, carrying each month nearly as many American citizens and British subjects as all the coolies carried in a year from Asia to Hawaii. In local business, therefore, this cable will be much better patronized than either of the other cables.

The North American terminals are two of the most rapidly advancing regions in the United States and Canada, namely, the State of Washington, which in the last census showed a greater percentage of increase than any other State, and British Columbia, the most energetic of all Dominion provinces; for, while other parts of Canada cannot prevent their inhabitants from emigrating to the United States, British Columbia has to pass laws to keep out Americans, for fear they will overrun it. The Asiatic terminals are the already built Russian and Japanese lines, and this cable thus unites four of the leading and most progressive nations of the world. If the Philippines be considered the objective point, Asiatic Russia, Japan, Corea, and China are way stations on the route. Alaska (including British Yukon) has a total trade of $40,000,000; Japan's foreign trade has grown from $59,000,000 in 1893 to $221,600,000, and in the same time her imports from the United States have grown from $3,000,000 to $20,000,000; Corea has a foreign trade of $10,000,000, Asiatic Russia of $51,000,000, China of $277,000,000—a total of $599,000,000, ex-



POLAR MAP SHOWING VARIOUS PROPOSED ROUTES FOR THE PACIFIC CABLE, WITH SUBSTANTIAL ACCURACY AS TO COMPARATIVE LENGTH.

clusive of the Philippines. With the exception of the Russian business, all of this will find this cable the most direct and cheapest route, not only to the United States and Canada, but to Great Britain, Germany, and France. The business, great as it is now, has but begun. Before the cable can be laid the Siberian Railroad will be completed to the Pacific. Already four Trans-Pacific lines of steamers run past Cape Flattery to Japan, a dozen different lines run up the Alaskan coast, there is a monthly service to Dutch Harbor. This activity sufficiently indicates that this cable is on the "track of trade."

The estimates for the southern cables were $7,500,000 and $10,000,000 respectively. For the short northern cable, to connection with both Russian and Japanese lines, the estimate is $2,400,000, or $500 a mile, which is $20 a mile more than the estimate of the British Commission (£53,000 for the 573 miles of British cable from Norfolk Island to New Zealand). Three million dollars will build the whole lines, including branches to Skagway, to Russia, and the 660-miles length from Japan to the Philippines.

The commercial rates now in force from London to Vancouver and Seattle are less than 35 cents per word, but the rate from London to Japan is $1.50, via Siberia, and $1.90, via Suez, and to Hong Kong, $1.40. (From New York it is 25 cents per word higher.) A dollar-per-word rate from London to Japan, 75 cents from New York, 65 cents from the Pacific Coast (this latter being one-third the present rate), ought to secure a large share of the business, and, instead of asking Japan for $200,000 per annum and the United States for $175,000, which is a guarantee of 5 per cent. on the alleged necessity of spending $7,500,000, the Alaskan coast cable could well ask Japan, Russia, the United States and Canada between them to guarantee $150,000, unless otherwise earned. With such a guarantee, and with its paying local business, this cable could dictate terms to the European-Asiatic lines and obtain a renunerative share of the business.

Not only is this cable in short lengths, cheap to lay and easy to repair, but the sea depths are not excessive. The deepest sounding between Sitka and Attu is 2,741 fathoms, the deepest between Attu and the Russian-Japanese boundary—(Choumchoum Island and Cape Lopatka) via Bering Island is 2,400, and the deepest in the Sea of Okhotsk is 1,848 fathoms. From its American-Canadian terminal to Sitka, a distance of 765 miles, the cable lies in shallow, smooth water, and breaks could be quickly repaired by a small tug boat. From Sitka to Chirikof Island it would add but a few miles to the distance to lay the cable within the thousand-fathom line. From Chirikof to Dutch Harbor, 440 miles, the depth is but 137 fathoms. The cable should be laid through Onimak Pass from the south to the north of the Aleutian Islands, because the north side has better harbors, is freer from fogs and storm, has shallower and more even bottom, and is also in a more direct line. The pass is nine to ten miles wide in its narrowest part, is clear of hidden dangers, free from dangerous tide rips, and with less tidal current than any other pass. The cable should land in Unalaska Bay, which lies between Cape Kalekhta and Cape Cheerful, and is commercially the most important bay in western Alaska. On the east side of the bay are the important anchorages of Iliuliuk Bay, Dutch Harbor and Iliuliuk Harbor. Cape Cheerful, the western entrance to Unalaska Bay, is made of bold, very high headlands, intersected by deep grassy valleys. The shore is free from dangers and has deep water close to. In Dutch Harbor a wharf 200 feet long extends to deep water, and at the outer end large ships can lie.

Three objections have been made to the northern route. They are that it lies in perennial fog banks, that it crosses the track of severe storms, that owing to its northern path it is subject to magnetic interference. The truth is that the region is not more stormy or foggy than the north Atlantic, through which the thirteen European-American cables are laid. Nor is the ocean further south a region of perennial calm. In the spring of 1898 one of the large Nipon Yusen Kaisha steamers, on her way from Hawaii to Seattle, rolled almost continuously 45 degrees by pendulum measurement, and in September of the same year another steamer of 2,000 tons, which had safely in winter time made the trip from New York to Seattle around South America, was shaken to pieces 400 miles northeast of Hawaii. On neither occasion would it have been an easy task for any steamer, however large, to grapple for a broken cable in 3,000 fathoms.

Alaska generally seems subarctic, and the erroneous impression is conveyed that a cable via Alaska must lie very far north. In reality, all of it lies south of the latitude of Aberdeen, Scotland. It runs northward to Sitka (57° north latitude), thence southwestward in an air line to the north islands of Japan. At Sitka it is but 300 miles north of the Atlantic cables landing on Ireland. Magnetic disturbance can be but inappreciably greater than in the Atlantic cables, and apprehension on this score may be safely dismissed.

There are no data by which accurately to estimate the probable amount of paying business on any cable line, but an estimate can be made of the fixed charges and from these the volume of business at a given tariff be stated, necessary to make the enterprise a paying one. The British commission has made such estimates for the All-British cable, and these give a basis for equally valuable guesses for the Alaskan Coast cable. For convenience of comparison these estimates are tabulated together.

	First cost.	Int. 5% Sinking fund 3%	Maintenance.	Operation.	Total.	No. of words to earn this at 75c. a word.
British Cable.	$10,000,000	$800,000	$350,000	$110,000	$1,260 000	1,680,000
Alaskan Coast Cable.......	$3.000,000	$240,000	$114,000	$70,000	$424,000	565.300

There remains one more route to consider, namely:

THE OVERLAND ROUTE, VIA THE YUKON RIVER.

As is well known: the Western Union Telegraph Company attempted to explore an overland route to Asia and thence on to Europe (before the Atlantic cables were a success, and when it was still feared that so long a cable could not be successfully operated). It is said that several million dollars were spent in this attempt. Telegraph Creek, on the Stikeen River, in British Columbia, a place that acquired some prominence last year as a possible starting point for an all Canadian overland route to the Klondike, is in its name a reminiscence. At that time San Francisco was the nearest telegraph point on the Pacific coast, and nearly all the way to Bering Straits, a distance of 4,000 miles, was an unexplored wilderness. All this has been changed. The Yukon valley is now well known and travelled summer and winter from Bering Sea to Skagway. Over the worst part of it all, the divide between the Pacific and the headwaters of the Yukon, a telegraph line has been built, and was in operation last winter. A railroad runs over this pass, and the telegraph line has been continued well down towards Dawson. The Canadian Government has undertaken to put in the line between British Columbia and the Yukon valley, and thus Dawson will soon be connected by wire with the civilized world. A line of less than a thousand miles, and through a country less severe in climate and in snow fall than the upper Yukon, would connect Dawson with St. Michaels, the port at the mouth of the Yukon. Thence by a series of short cables, either via the American islands, St. Lawrence, St. Mathew and Attu, or from headland to headland on the Asiatic coast, the Russian-Japanese boundary could be reached.

One thousand miles of land line and two thousand miles of short cables would connect Dawson with the Russian or Japanese lines, but the objections to this project are many. Owing to the high latitude a long land line is very liable to magnetic disturbance, especially in winter; it is also liable to break-downs from storm and snow, which might interrupt communication for several days at a time. I have seen hoar-frost form a rope six and eight inches in diameter on the line north of Skagway, and break it down repeatedly. There might be even more trouble with the cables. Bering Sea is very shallow, its shores are ploughed by fields of floating ice, which might rake up the shore ends of the cables, and repairs, in case of break, would be impossible, except in summer time.

Which of these four routes shall be selected—or, unfortunately, shall two or more lines be attempted at once?

A great commercial enterprise is incompatible with a narrow nationalism. If the western coast of North America is to reap the Asiatic harvest, ready for the gathering, a direct Pacific cable must be laid to Asia, as business cannot successfully be transacted either via London or via Australia. If the United States and Canada are conscious of their imperial position between the two great oceans of the world, between the great marts eastward and westward, they will not long permit this last ocean to remain unspanned. Here is a great world market at their western door, opening a hungry mouth for food and clamoring for manufactures, both of which North America so abundantly and splendidly produces. In spite of their misunderstanding over the Alaskan frontier, Canada and the United States should join hands in laying the shortest and best cable to the oriental world, forcing European messages and European trade to come their way through the San Juan de Fuca Straits, with its cluster of American-British cities, through the great Columbia River to Portland, through the Golden Gate to San Francisco.

It is not an impracticable and ruinous national cable, whether British or American, that is needed, but a cable that will bind closer in friendship and in swelling trade relations the United States, Canada and Great Britain of the west—Russia, Japan, China and tropical Asia in the east.

ELECTRIC POWER DISTRIBUTION AND THE SMALL CONSUMER.

By Louis Bell.

ONE of the toughest problems that faces the political economist is the preservation and regeneration of small industries. The present tendency is toward the aggregation of both population and industry into a few well-defined centres. It is idle to say that this is the natural course of progress, proceeding from well-defined economic laws, useless and needless to combat. On the contrary, while man is naturally a very gregarious animal, and certain localities are unquestionally more advantageous than others, the major part of the centralization of industry, in its most modern phases, arises from the effort to control and inhibit the operation of economic laws. For example, the arbitrary limitation of production, the temporary sale of products below cost to suppress competition, the whole complicated system of equalization of freight rates—all these are purely artificial methods of forcing industry out of its natural channels, which themselves, like river beds, shift from time to time. To such processes, generally contravening the public good and often the laws of man and God as well, is due no inconsiderable part of those industrial changes which are affecting so disastrously the distribution of wealth and prosperity. But one must face the problem as it is. The existing condition is that the distributed industries of the country are steadily passing away, towns once prosperous are declining, thriving villages are being succeeded by tumble-down hamlets and well tilled farms by weed-grown pastures. This is no fanciful picture; it reproduces, with uncompromising fidelity, what all may see who overlook such parts of the United States as are not purely agricultural in their interests. Meanwhile the larger cities are growing with mushroom-like rapidity, and the whole trend of events is toward economic development of a terribly unstable character, likely to alternate between feverish prosperity and complete prostration.

The subject is one of gigantic proportions and ominous of disaster, too vast and complex for treatment by any single hand or along any single line. It is the purpose of the present paper merely to point

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Dr. Bell's paper fulfils the promise with which his article in the preceding issue of THE ENGINEERING MAGAZINE concluded. He shows how the centralisation of power ministers to the distribution of industry. It is one of those beneficent paradoxes of out how some of the forces that make for progress, and with progress bring some evil concomitants, may be turned to remedy the evil.

In theory, production on a large scale, other things being equal, must inevitably prevail. But, in the first place, the curve which expresses the relation between cost and output in many cases rapidly becomes asymptotic, and, in the next place, the other things seldom are equal, and may be made to favor the small as against the large producer. In a previous paper I have explained how modern methods of work-shop development, when carried beyond a certain point, may tend to defeat their own ends. The same tendencies operate in a more general way to produce the same results in almost all industries, the more powerfully in those branches of manufacture which call for high individual skill on the part of the workman.

The three prominent essentials of cheap manufacture are cheap labor, cheap power, and cheap raw material; with these we must also consider cheap distribution of the finished product. In the earlier stages of industrial growth, while production was still distributed, manufactures gathered around the sources of material, near water powers, or at the seaboard, according to the relative importance of these various factors of cost—labor being, for the time, fairly uniform. With the coming of the railroads, the transport of material and product became relatively cheap, and railroad centres became, if power was available, economical points of manufacture. The stress thus put upon other districts forced labor to follow on to the cities, which, with the introduction of machinery, steadily cut down the labor cost, while low railroad rates on through traffic have steadily increased the advantage of the large centres of population. One might naturally suppose that the higher cost of living in cities might increase the cost of the labor item, but the sharper struggle for existence has more than offset this difference. The upshot of the matter has been that the distributed industries have been, as a rule, slowly starved out of existence until, one after another perishing, the whole industrial situation has changed. In a few instances, brickmaking for instance, widely scattered raw material, with product costly to transport, has prevented the concentration of manufacture; but these are exceptions.

If the present condition—disastrous in its effects on the earning

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industrial evolution which are so generally unforseen or misunderstood by superficial students and thinkers. As labour-saving machinery has largely emancipated the workman from drudgery, while immeasurably increasing the field for his employment—as specialisation, according to Sir Benjamin Browne, elsewhere in this number, is destined to individualise, and not formalise, his effort—so, Dr. Bell maintains, centralisation of power may afford, in the end, the solution for over-concentration of the labouring population. THE EDITORS.

power of the people at large—is to be changed, it must be through changing the factors upon which cheap manufacture depends. Bringing a cheap product to the consumer is undeniably a good thing; but if this end can be reached without a centralization that materially lessens the consumer's relative earning power—so much the better.

The factors of cost most susceptible to attack are the cost of power and the cost of local transportation, both of material and product. The first mentioned is usually rather high in the larger cities, but higher still away from them owing to the heavy transportation charges on fuel. Save in the case of some of the older cities, built up around water powers, these are more available in country districts; but, again, the transportation facilities are generally bad, since the immediate vicinity of good waterfalls is apt to be a difficult country for the construction of a network of railroads.

The electrical developments of the last decade have, however, cleared the way for at least a partial solution of this difficult problem of saving and restoring distributed industries. The most sanguine engineer would hardly put forward his art as a panacea for these economic ills—other and more drastic remedies must come at the hands of the long-suffering people if they would save themselves from industrial serfdom; but, nevertheless, electric power is no insignificant factor in the situation. At the present time we must look upon water powers not merely as local privileges, but as available anywhere within a radius of, say, twenty-five miles in almost every instance, or at several times that distance in regions where fuel is dear.

A twenty-five mile transmission is to-day a mere commonplace of engineering, a little longer than is usually necessary, but in other respects quite in accordance with every-day practice. And this means that if, within such distance of a water power, there are locations otherwise desirable for manufacturing purposes, the power user there will be in a better situation economically, so far as cost of power is concerned, than his large competitors who have to depend upon steam. And all along the line of such a transmission this industrial advantage exists. It is only very recently, however, that the full significance of the situation has become manifest in its application to scattered manufactures. We have been wont to look on a power transmission as something like a trunk line between well-defined termini, but now we should do well to apply to it something of the theory of railroad location and note, not alone the ends of the line, but what points between may be profitably served. Frequently, indeed, these opportunities are not overlooked; but the first important transmission deliberately intended for serving a distributed industry we must place to the credit of our Gallic friends, to whom, moreover, we owe the very beginnings of electrical power transmission.

This notable enterprise, which marks, perhaps, the beginning of a path that leads to far wider fields, was inaugurated to save the ribbon-weaving industry in that part of the Loire valley that lies near St. Etienne. Ribbon weaving is there the most important local employment, and until a few years since it had been for several generations carried on entirely upon hand looms, excellent for the purpose, but obviously unable to compete with large factories equipped with power looms. It formed the chief support of more than a score of towns and villages, for the looms were rarely gathered in factories, but scattered from house to house in small work-shops containing seldom more than two or three looms. It was practically work done in the homes of the weavers, and the trade was passed down from father to son. Under the competition of improved machinery in city factories, the industry around St. Etienne languished, and villages and workshops seemed doomed to extinction. The crisis had become serious when the Compagnie Electrique de la Loire undertook to avert the catastrophe.

The resulting system is shown upon the map (p. 245). The first step was the installation of the water-power station at St. Victor-sur-Loire, having 900 h.p. in turbines and a steam reserve of 600 h.p. The three-phase system was adopted, the voltage of transmission being 5,200. This initial station was 15 kilomètres from St. Etienne, and it was soon followed by a 400-h.p. hydraulic station at Pont-de-Lignon, about 40 kilomètres from St. Etienne. In the latter town, three steam-driven stations were installed, aggregating 900 h.p. more. The distribution, in every case, is at 190 volts for motors and 110 volts for lighting. The system has been steadily extended from town to town, until at present the total length of the transmission lines aggregates 110 kilomètres (nearly 69 miles) with thirty-six transformer stations from which power and lights are distributed. From these are operated two thousand five hundred ribbon looms, 100 h.p. in miscellaneous motors and eight thousand incandescent lamps. A ¼-h.p. motor serves for each loom, so that the total load connected amounts to about 1,400 h.p. All the lighting is outside of St. Etienne, since the local gas company holds exclusive rights there. The charge for power to the weavers is 10 francs per month for each ¼-h.p. motor. As far as can be learned, the system has been an all-around success, and the substitution of power for hand labor has greatly improved the industrial conditions, in spite of the fact that, through the slow conservatism of the small weavers, many hand looms are still in use. To encourage further use of motors, arrangements are made for the supply of the motors at a nominal rental, or the user is at liberty to furnish his own motor, if of a kind suitable for installation upon the circuits.

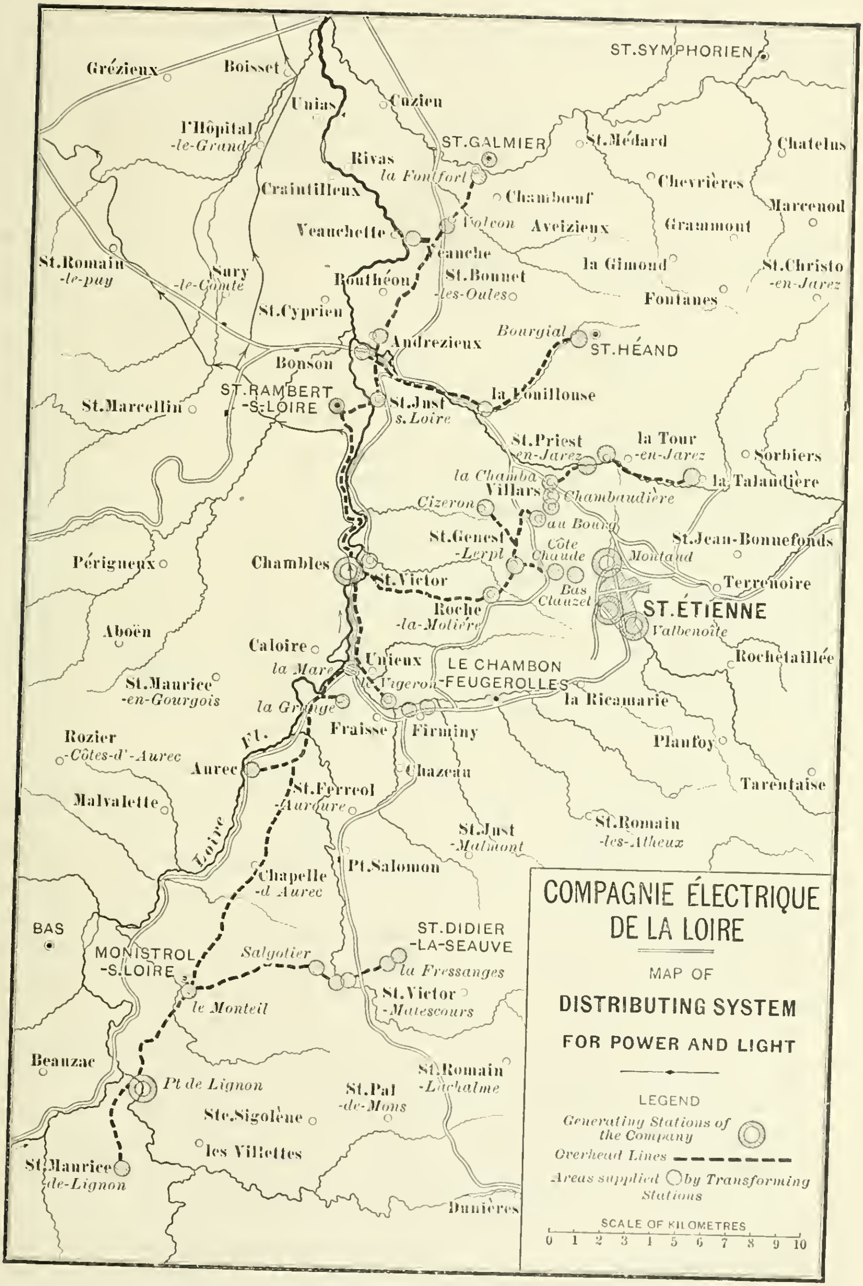
This St. Etienne transmission is at present absolutely unique in the great area supplied and in the almost complete absence of large customers.

Of course, the fundamental question about so scattered electrical distribution is the financial one:—Will it pay? At the St. Etienne rates there can be no doubt of an affirmative answer. Competition there is between hand labor and motors, and the latter obviously have the advantage. A more searching inquiry would be as to whether a similarly extensive distribution from water power could profitably furnish power to small consumers at rates comparable with the ordinary cost of power to larger users in cities. The best answer is the solution of a hypothetical case involving the above conditions.

For simplicity, we will assume a plant of about 1,000 kilowatts normal capacity, distributing power 25 miles in two directions, thus being located nearly midway of a 50-mile line, and delivering power and lights from, say, twenty points. This is somewhat less elaborate than the St. Etienne distribution, but the latter has the advantage of a shorter transmission for the main load.

The most uncertain figure is generally the cost of the hydraulic privilege. This I shall assume at $20 per h.p. for about 1,500 hydraulic h.p., a rate closely corresponding to various recent sales of medium-sized powers. The electrical station and its equipment may safely be taken at $30,000, and hydraulic development, including wheels, at $40,000. Taking the transmission at, say, 15,000 volts, the line could be put up for about $1,000 per mile, making $50,000 more. Allowing $2,000 for lines and apparatus at each of the twenty distributing points, and a small margin for contingencies, one may say, in round numbers, that the complete installation would not cost more than $200,000. The operating expenses, general expense, and depreciation, including repairs, should not exceed 15 per cent. annually, bringing the annual cost, exclusive of capital charges, to $30,000. Such a plant could carry at least the equivalent of 1,200 h.p. in paying load of lights and motors. At $50 per h.p. per year, this would give a gross income of $60,000, enough to net 15 per cent. on the investment.

Full-load conditions are, however, the exception in cases where


Grézieux
Boisset
Unias
Cuzieu
ST.SYMPHORIEN
l'Hôpital -le-Grand
Rivas
la Fontfort
ST.GALMIER
St.Médard
Chatelus
Chevrières
Craintilleux
Chambœuf
Marcenod
Veauchette
Volcon
Aveizieux
Grammont
Veauche
St.Romain -le-puy
Sury -le-Comte
Bouthéon
St.Bonnet -les-Oules
la Gimond
St.Christo -en-Jarez
Fontanes
St.Cyprien
Bourgial
Andrezieux
ST.HÉAND
Bonson
ST.RAMBERT -S-LOIRE
St.Marcellin
St.Just s.Loire
la Fouillouse
St.Priest en-Jarez
la Tour -en-Jarez
Sorbiers
la Chamba
la Talaudière
Villars
Chambaudière
Cizeron
au Bourg
St.Genest -Lerpt
Côte Chaude
St.Jean-Bonnefonds
Périgneux
Chambles
Montaud
St.Victor
Terrenoire
Bas Clauzel
Roche -la-Molière
ST.ÉTIENNE
Aboën
Valbenoîte
Caloire
Unieux
LE CHAMBON -FEUGEROLLES
Rochetaillée
la Mare
le Vigeron
St.Maurice -en-Gourgois
la Ricamarie
la Grange
Fraisse
Firminy
Rozier -Côtes-d'-Aurec
Fl.
Planfoy
Aurec
Chazeau
Tarentaise
St.Ferreol -Aurôure
Malvalette
St.Just -Malmont
St.Romain -les-Atheux
Loire
Chapelle -d Aurec
Pt.Salomon
BAS
ST.DIDIER -LA-SEAUVE
MONISTROL -S.LOIRE
Salgotier
la Fressanges
le Monteil
St.Victor -Malescours
Beauzac
St.Romain -Lachalme
Pt de Lignon
St.Pal -de-Mons
Ste.Sigolène
les Villettes
St.Maurice -de-Lignon
Dunières
COMPAGNIE ÉLECTRIQUE DE LA LOIRE
MAP OF
DISTRIBUTING SYSTEM
FOR POWER AND LIGHT
LEGEND
Generating Stations of the Company
Overhead Lines
Areas supplied ○ by Transforming Stations
SCALE OF KILOMETRES
0 1 2 3 4 5 6 7 8 9 10

the output is distributed to small customers. In a plant such as we are considering, one is far more likely to get something such a load as at St. Etienne, say 500 h.p. in motors and perhaps five thousand incandescent lamps. Even this means success, since the lamps should yield an income of not far from $25,000 yearly and the motors as much more. Speaking broadly, one can safely count on a good return upon the capital, even with a distribution considerably scattered, if there is, in the aggregate, business enough for a fair total load.

The rate suggested, $50 per h.p. per year, is generally lower than the actual city prices paid for power in the United States by fairly large users. The selling price for electric power from central stations is considerably in excess of this amount, and at $50 per year per h.p. it would pay to shut down even some pretty large steam engines.

Power distribution involving shorter distances than those considered is accomplished still more cheaply, and the price is often reduced considerably below that mentioned. If the market is in one or two towns, so much the better. It is not an easy matter to evaluate the present average cost of power to small users in the United States, but, taking a general view of the conditions, it is probably well within bounds to say that few consumers of 50 h.p. or less can obtain their power for less than 5 cents per h.p. hour actually employed. Until one comes to large factories 2.5 cents per h.p. hour (actual) is below rather than above the mean.

It is clear then that electric power at $50, or even $60, per year, really puts the small consumer in a little town on a level with his larger competitor in the city so far as this consideration is concerned. And while, in the cities themselves, large and small consumers both gain by cheap electric power, the little fellow gains the more conspicuously. In the long run it is to the advantage of those who supply electric power to cultivate the small user, since a price which will neatly square him with a much larger competitor will generally not attract the latter. The big user commonly underestimates the cost of his power more than the small one, and hence is more greedy in driving a bargain. Even the very small user—the chap with a ¼-h.p. motor and half a dozen lights—is never to be despised; he fully realizes the advantage he gains, and is often quite as good pay as larger customers.

The point of the matter most important to the wider view is the fact that electric power can be supplied profitably, in very many instances, at rates which put the small user in the small town on a parity with his larger rivals, aside from the immediate gain that can be made by substituting motors for steam or gas engines. The development of water powers gives an opportunity for building up, all over the country, industrial communities that will infuse new life into the dying prosperity of the rural districts. And one of the most curious features of the growth of electric-power transmission, which has made this possible, is the way in which unutilized water powers have come to light in the most unexpected fashion and in the most improbable places. Some one remembers that years ago, before the great western States both raised and ground half the world's grain, there was a grist mill on a back country stream. Its site is looked up after some difficulty and a brief survey develops the fact that reasonable improvements will yield several hundred horse power.

The utilization of such powers is not only a powerful agent for the regeneration of manufactures, but less directly it may be of great benefit in promoting cheap electric-railway service. As has been already pointed out, the rural communities and smaller towns in the United States are severely handicapped in the matter of transportation. Not only do they suffer from being off the main highroads of traffic, but from unjust discrimination in freight rates. Until the iron hand of the government falls, as it should have fallen long ago, upon railways dishonestly managed, four-fifths of the country people will be taxed for the benefit of the other fifth. About the only present defense is the improvement of local means of transportation. Light electric roads, carrying both passengers and freight, are capable of working wonders in this line of progress. Within limited distances they are able both to deliver goods at very low rates themselves, and to work the thumbscrew of competition upon the unwilling hands of the railroads. Aside from these public ends that may be served by electric power, however speedily or slowly they may be reached, there comes the hard, practical, every-day question of economy for the existing small consumer. This, the more common-place side of the subject, we may now properly consider.

Save in rare instances, small amounts of power—say from 50 h.p. down—are derived from steam or gas engines operated on the premises of the user. More rarely power from shafting is rented, or water motors are available. Small steam engines are both inconvenient for occasional use and notoriously inefficient at all times. When operated steadily, they cause a heavy drain upon the coal pile, and, when used intermittently, not only waste fuel but roll up against each h.p. hour furnished a round charge for attendance, interest, depreciation, and repairs. To estimate with precision the average total cost per h.p. is out of the question, but it often reaches $150 per h.p. per year, rarely falls much below $100 and, where the average output is 10 h.p. or less, not infrequently rises as high as $200. Since most small prime movers are used intermittently and at rather light load, such a yearly estimate of cost puts the case less pertinently than an estimate per h.p. hour, and the figure of 5 cents, already given, is pretty near the truth. In blocks of 25 to 50 h.p. and fairly steady use, it may often be reduced; but, on the other hand, in cases of very intermittent use and in smaller powers 5 cents is often an underestimate. Small gas engines are preferable to steam engines under such circumstances. Oil engines are still cheaper as regards material consumed, but at present practically make up the difference in greater care and depreciation. It is quite certain that the next few years will, thanks to the coming of the automobile, show great improvements in the convenience and economy of small prime movers. Possibly the present cost may be cut squarely in two, but, even so, there will be a wide margin still left for the electric motor.

It has been shown already that, even when handicapped by a somewhat difficult distribution, electrically-transmitted water power can be sold at a profit as low as $50 to $60 per h.p. per year. With the denser service of a good sized town, this figure can be maintained even when the hydraulic costs are higher than those cited.

Even when electric power is furnished from a steam plant, these prices could be met if a sufficient load could be assured. Large generating stations can to-day put electrical energy upon their circuits at a total cost somewhat under one cent per h.p. hour. Adding to this the necessary expenses for distribution, there is still a good margin for profit—certainly at the higher price mentioned—if ample load can be obtained. The hydraulic station can work on a smaller scale and afford equal, or better, prices.

The saving between electric-motor service and the cost of power generated in small units, even discounting probable improvements in the latter case, is still material. $20 per h.p. per year is, and always will be, worth saving, and this amount is usually within reach. If, moreover, we look forward a little and bear in mind the elements of future progress and prosperity, the advantages of electric power for small consumers become even more manifest. Urban life demands an abatement of the nuisances caused by innumerable small and large engines within our city limits. With the wholesale use of electric power these can be eliminated—not at increased cost to those who would maintain them, but at a saving large enough and positive enough to be in itself a sufficient reason for the change.

THE DEVELOPMENT OF GERMAN SHIP BUILDING.

By Rudolph Haack.

IV.—THE YARDS FOR THE BUILDING OF RIVER BOATS.

WITH the betterment and increase of navigable inland German waters, there has also been a development and growth in the building of passenger steamers and cargo boats for this traffic, so that to-day it makes up a very important part of German ship-building, in which, however, many of the yards situated on or near the sea-coast take part, and this has been mentioned as their output was described. It is, however, the main business of the following yards, situated on the inland rivers; and we begin with the following yards, situated on the inland rivers; and we begin with the Rhine and yard furthest from its mouth, that of the Schiffs-und Maschinenbau-A. G., formerly Schulz Bros. and Bernard Fischer in Mannheim; the business was founded in Mainz, relocated in Mannheim in 1882, and in 1893 taken over by the present joint-stock company. This firm builds steel ships of every kind for the Rhine and its tributaries, and its turnover in 1897 was 1,200,000 mk. The total yards, slips, etc., cover an area of 7½ acres and employment is given at the present time to twelve engineers and three hundred and fifty-four workmen, who in 1898 built eighteen steamers and boats, and still had ten on the ways. The total tonnage was 2,182 gross. Foreign orders for boats came to this yard from Roumania, Switzerland, and Russia, and the largest built had a length of 237 ft. The heaviest engine built was of 250 i. h. p. The repair shops and ways, which can drag out boats up to a length of 295 ft., are steadily occupied. The

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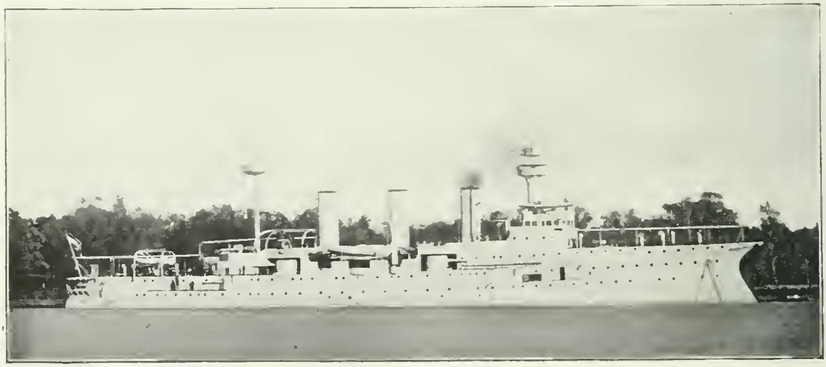
Herr Direktor Haack's papers have been remarkable, in that they have presented not only a clear review of the material progress and present status of the ship-building industry in Germany, but with it a very lucid study of the economic and sociological business is now managed by Mr. R. Blümcke and has a high reputation both with governments and shipping firms, from whom its chief orders come.

The largest yards on the Rhine are those of the firm Chr. Ruthof, in Castel, which builds mainly boats for the Rhine and, including boats still on the ways, it turned out in 1898 twenty-four boats of 10,534 gross tonnage. Of these, however, only two were steamers, with engines of a total of 700 i. h. p.

Further down the Rhine, in Coblence, the firm of Schaubach and Grämer built only one steel boat of 331 gross tons registry, but the next firm, that of E. Berninghaus in Duisburg, built twenty-two boats of 6,041 gross tons. The Meidericher Schiffswerft in Meiderich built 536 gross tons, and the yards of the Dortmunder Union Act. Ges. für Bergbau, Eisen-und Stahl-Industrie, at Dortmund, which did its first work in 1898, built six boats of a total of 840 gross tons.



GERMAN CRUISER HERTHA, SECOND CLASS.

344½ x 57 x 37 ft.; 5,630 tons. 10,000 i. h. p., 19½ knots. Built at Stettin, 1897-98.

There is much activity on the Elbe also in the building of river boats, and in 1898 the Dampfschiff-und Maschinenbau-Anstalt der Oesterreichischen Nordwest-Dampfschiffahrts-Gesellschaft in Dresden built ten steamers and tugboats, with a total gross tonnage of 2,914 and the "Kette," Deutsche Elbschifffahrts-Gesellschaft, in Uebigau near Dresden, built twenty-one boats with a total gross tonnage of 3,689. Especial mention should finally and at the end of the list be given to the yard of Gebrüder Sachsenberg Ges. m. b. H. in Rosslau-

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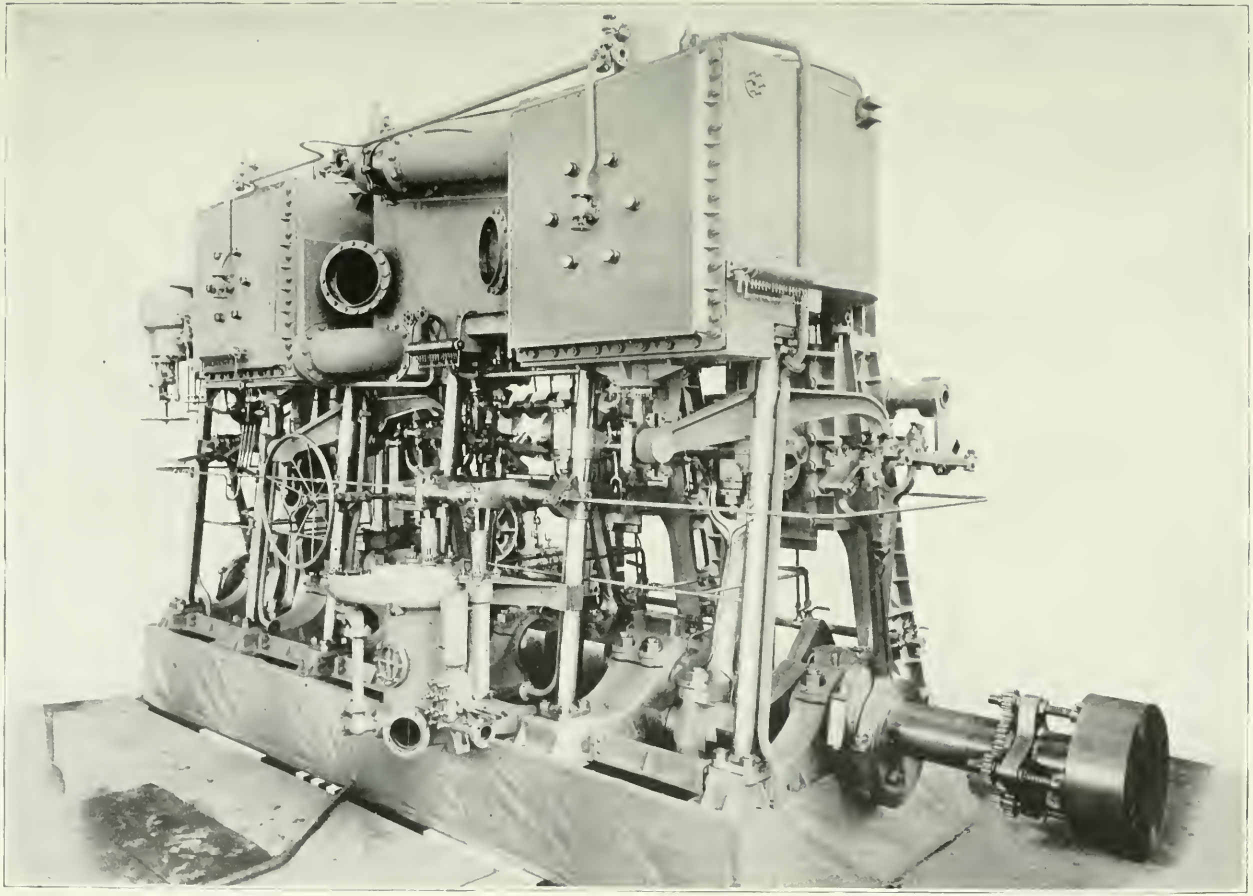
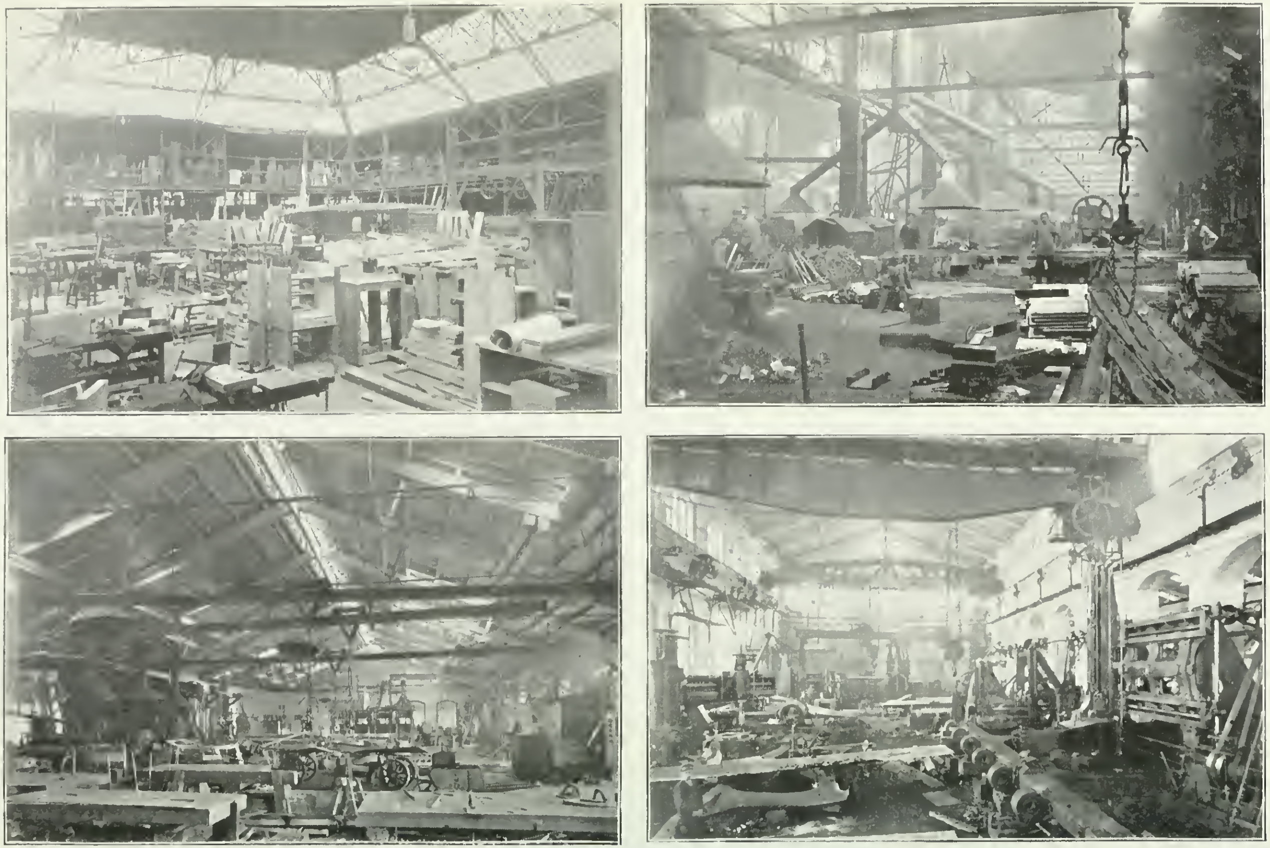
influences under which this industry has been developed. The concluding article of the series, in this issue of THE ENGINEERING MAGAZINE, is a brilliant example of Herr Haack's style and method. It epitomises the history of German marine and naval engineering—a branch of work which itself includes almost every line of engineering activity. THE EDITORS.



ONE OF THE THREE FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE GERMAN CRUISER HERTHA.

10,000 i. h. p. Schlick counterbalancing system. Built at the Vulcan Works.

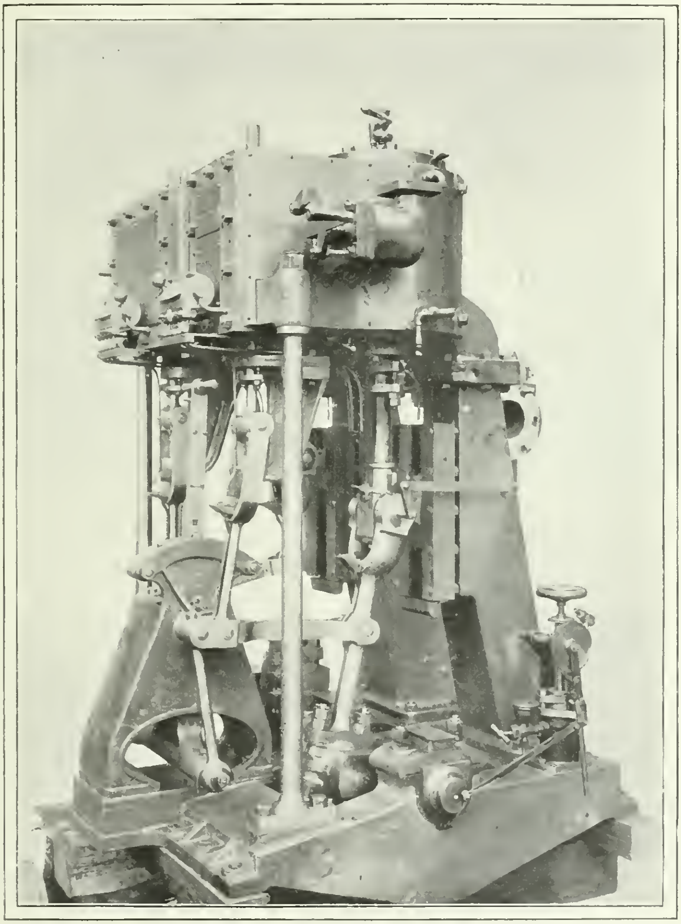


FOUR VIEWS OF THE INTERIOR OF THE VULCAN WORKS AT STETTIN.

Wood-Working Shop.
Forge Shop for Frames.

Marine Forge Shop.
Armour-Plate Shop.

an-der-Elbe, which was founded in 1868 by Messrs. Gottfried, Friedrich, und Wilhelm Sachsenberg, who had been running a machine shop since 1844. Up to 1888 this firm built wooden vessels, and later iron and steel boats. The yards cover an area of about 55 acres, and the company builds passenger steamers, cargo boats, tug-boats, etc., for rivers, canals and coast trade, and also stationary engines, boilers, brick-making machinery, shot towers, distilling apparatus and machinery, paper-mill machinery, etc. Owing to location of the yards on the lively Elbe there is a constant demand for repair work, and

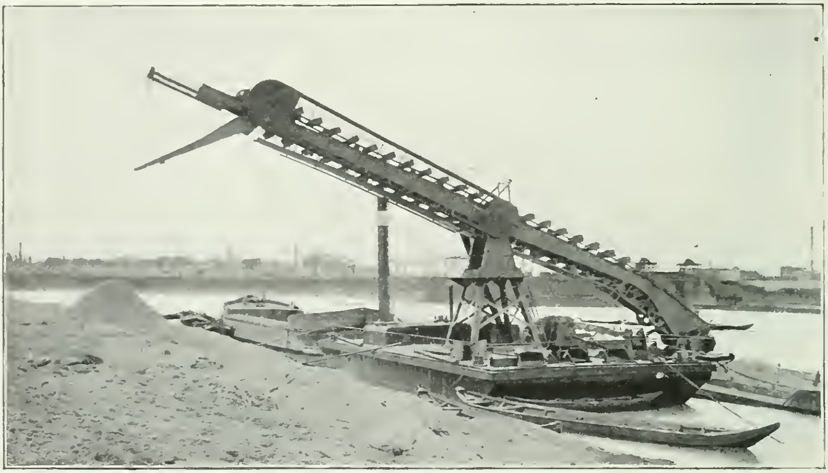


COMPOUND MARINE ENGINE FOR A SMALL STEAMER.

$\frac{250 \times 450}{300}$ millimeters; 125 i. h. p.; built by the Mannheim Ship and Engine Building Co.

traction ways for river boats are suitably installed and almost always occupied.

Last year this firm employed one thousand workmen and the seven completed boats and the five still on the ways amounted to a total of 4,741 gross tons, with engines of 6,250 i. h. p.; one steamboat was destined for the Rhine and another for Bolivia. This company, which builds all its boats and executes all its work with the greatest care and skill, deserves great credit for its improvements in river boats and especially in their engines and machinery.



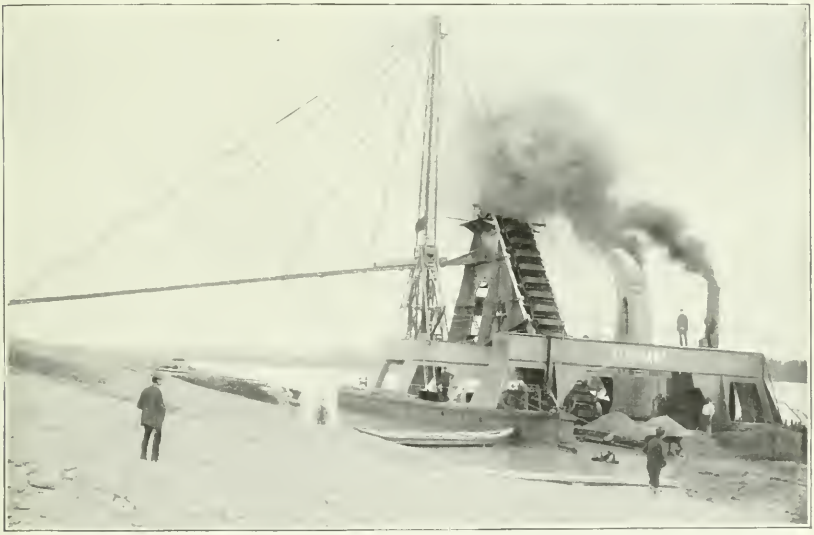
ELEVATOR FOR HANDLING AND DISCHARGING DREDGED MATERIAL.

The conveyor takes the spoil from scows or barges and delivers it onto the bank or into waggons. Capacity, 130 cu. yds. per hour; requires 60-65 h. p. Constructed to take down for transportation overland. Built at Mannheim.

All the German yards were busy in the year 1898 with the building of five hundred and twenty-eight vessels of 546,461 gross registered tons, of which three hundred and thirty-three, of 208,835 gross registered tons, were completed and, at the end of December, 1898, one hundred and ninety-five vessels of 337,626 gross registered tons still unfinished. There is, therefore, certainty of greatly-increased tonnage during the current year, especially as orders are pouring in more numerously than ever before. The total cash turnover of all the yards of Germany for 1897, including those whose official figures we have given and an estimate for the others, amounts in round numbers to 120,000,000 mk., an important figure which in 1899 will be very markedly larger.

From the short description of the several yards and plants on sea-coasts and rivers it is seen that nearly all of them manufacture other things not directly connected with ship-building and marine engines. When the building of iron and steel ships first began, this activity and skill in other directions was of the greatest advantage; for without this outside source of revenue in the period before 1890 many of the enterprises would have suffered great pecuniary embarrassment, if indeed they had not failed entirely. Nevertheless, most of the plants were founded for ship-building only, and will continue to exist for it. How long a time and to what extent the auxiliary business will be kept up cannot now be determined.

There is no uniformity in the relative number of staff and workmen employed, tonnage delivered, and indicated horse power of engines. No accurate comparison in this respect is possible, because the kind of work and the manner of its execution varies so much. In general, there is relatively a larger staff of engineers and employees in the yards where battle ships and the large fast passenger steamers are built, because these make bigger demands on intelligence and trained skill. The average of wages varies with the locality in which the yards are situated. Wages are highest in the great sea-ports of the North Sea, and lowest in the more easterly cities and towns of the Baltic;



CATAMARAN ELEVATOR FOR HANDLING DREDGED MATERIAL.

Capacity, 2.750 cu. yds. per hour; 90 i. h. p. The spoil is taken from the barge and delivered on shore through a spout or by a belt conveyor. Built at Mannheim.

but wages are rising everywhere. Many of the great companies not only do what is required by law for the disabled and sick, but voluntarily ameliorate, so far as they can, the condition of the workmen and their families, in the matter of educational and hygienic facilities. Many of them provide good dwellings on favourable terms, or organise sick- and relief-funds, co-operative stores, etc., take care of those who are needy, and look after the requirements of hygiene; and at the Sunday and night schools, especially for the younger workmen, opportunity is afforded to take elementary courses in mathematics, drawing, and other studies, so that these men may fit themselves to take positions later in erecting work, as foremen, and even as draughtsmen in the offices.

FLOTILLA OF THREE STEAM LAUNCHES AND TWO STEAM DREDGES.

Built for the Dortmund Ems Canal by the Mannheim Ship and Engine Building Co.

Next to the mental, physical, and moral welfare of a body of trained and skilful workmen, a suitable and adequate supply of raw materials for ship-building is most important. Its quality is the very basis of the excellence and duration of the hull of the ship, and its prompt delivery, in proper sequence, is absolutely essential in all contract work with specified time of delivery. The German sources for all timber used for earlier ships has already been mentioned, but all iron, and later all steel, had at first to be brought from Great Britain. German furnaces and mills were not prepared for this kind of work: they had no rolls for the many cross-sections, and the raw materials were too costly to enter into competition with the cheap British iron supplies for ship-building, especially as these were all admitted duty free, in order to give German builders a chance to compete. The same conditions continued to prevail even for a long time after the introduction of steel for ship-building, and several attempts were fruitlessly made to mend this state of affairs by some kind of union or agreement between ship yards and rolling millls. Plates could, indeed, be rolled, but angle irons and beams, such as ship-building required, could neither be manufactured nor supplied. The very limited demand for

STEAM LAUNCH FOR THE DORTMUND-EMS CANAL.

41.2 x 10 ft., 30 i. h. p. Speed, 9 miles an hour. Built by the Schiffs- & Maschinenbau-Akt.-Ges., Mannheim.

materials was not encouraging for the equipment of shops with the rolls necessary to supply all the cross-sections required by the many different types of ships. Little by little progress was made, and the real start is to be recorded from the date when the German navy began to build iron-clads and the Imperial Govern-subsidised mail steamers, to be built of German material; but very slowly did the mills install the necessary machinery to supply some of the required cross-sections. Very recently the iron mills have entered into a combination, with a central office, and to this all inquiries and orders for the whole of the ship-building supplies are sent, and in this manner every demand can be filled and the work is subdivided according to the equipment, facilities, and specialties of the several millls.

The difficulty has not even yet been wholly remedied, and quite an important volume of the orders for ship-building materials still go to England, and especially from those yards most distant from the iron centers, where the increased cost of land carriage over water transportation makes it too expensive to draw supplies from the inland German iron works in Westphalia or Silesia. Moreover, the yards could not afford to pay higher prices for steel when (and this was often the case), they were competing with British firms for orders to build cheap freighters. Therefore,

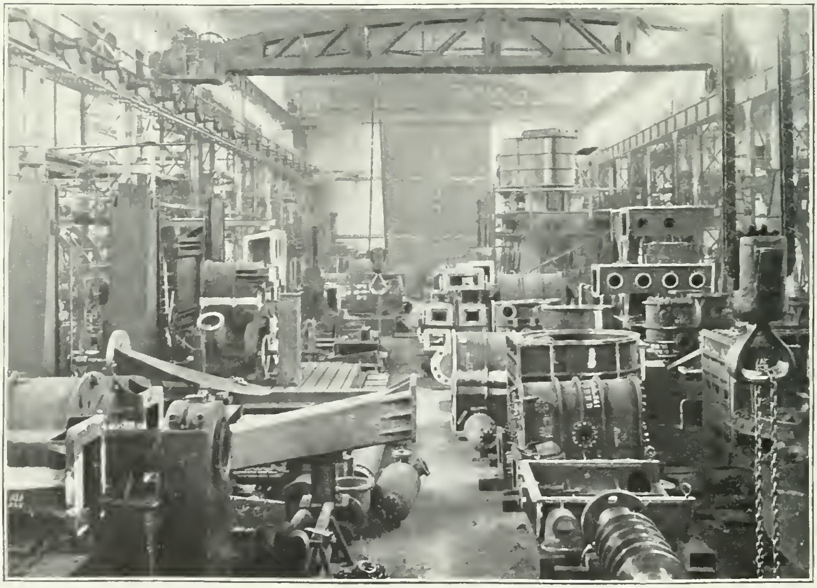
GOVERNMENT INSPECTION AND TOWING STEAMER.

66 x 13.2 x 5 ft., 125 i. h. p. Built by the Mannheim Ship and Engine Building Co

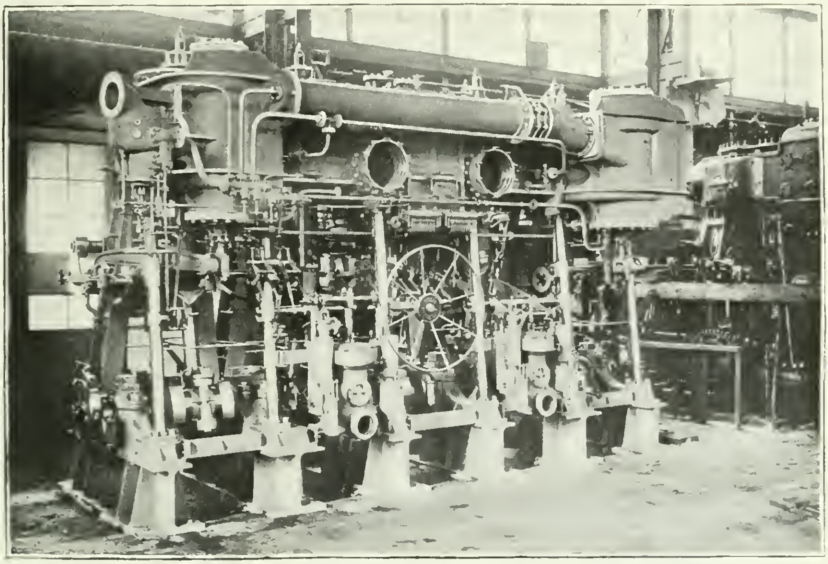
unfortunately, all ship-building material used in building German vessels is not yet of exclusively German origin, but this condition will not last much longer.

The above-described condition of affairs, as well as the recent overflow of orders and surplus of work in all German yards, has made it possible for certain shipping firms to order vessels in England and Holland. Including the vessels still on the ways on January 1st, 1899, not less than fifty-seven ships with a total gross tonnage of 103,176 tons were building abroad for German account. This is 18 per cent. of the total tonnage built in Germany, and in this total are included all foreign orders for German work. Foreign building of vessels for German account will soon cease, for, owing to the rapid increase in size and number of the ship-building yards, all vessels required will be supplied at home and the steps taken by the iron and steel manufacturers, as already described, will make the profitable import of British material unnecessary, if not inadvisable.

The Ministry of Public Works (which controls the state railways) intends to issue a special and exceptionally low tariff for the economical transportation of iron and steel material for the building of ocean and river craft, so as to facilitate the use of home supplies, especially by those yards most distant from the iron centers. German ship-



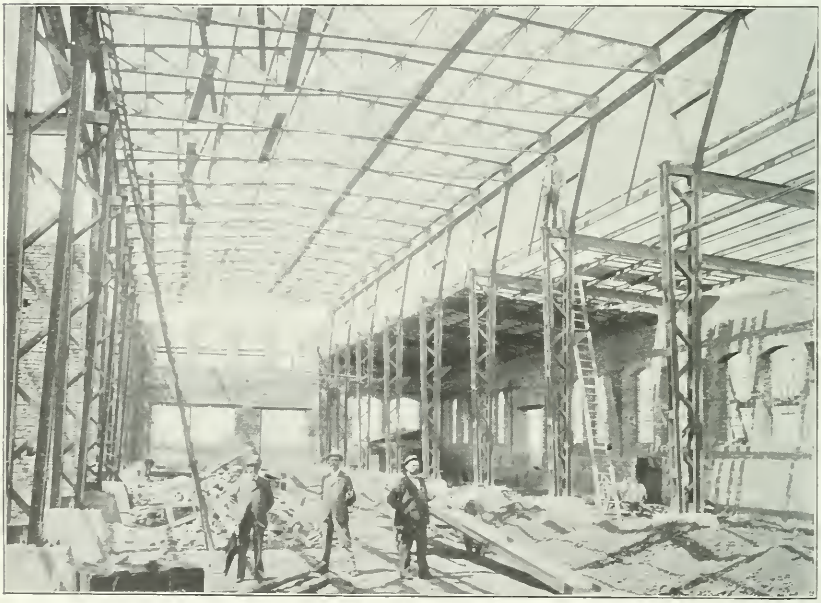
ERECTING SHOP, VULCAN WORKS, STETTIN.



FOUR-CYLINDER TRIPLE-EXPANSION ENGINE FOR 3,000-TON CRUISER.
7.500 i. h. p. Built at Stettin, 1897-98.

building is already self-sufficient and independent in the production of the largest forgings and castings for stern and bows, and for parts of machinery. They are supplied by Krupp of Essen and by others, and are of superior workmanship and wholly satisfactory. This is particularly true of the cast-steel shafts of every kind, these being splendidly made at Bochum. Armour-plate was first secured entirely from Sheffield, then made in Germany first by the Dillinger Hütte, in Dillinger a/S., and more recently, and of the highest grade, by Krupp, according to his own patents. This patent, indeed, has been purchased by all foreign plants which make a specialty of armour plate.

The large and luxurious passenger steamers of the North German Lloyd, which were built in Great Britain, were also equipped and finished there in all their interior work. For some of the later steamers, the interior designs were supplied by Architect Poppe of Bremen, but for the "Lahn" all the joiners and cabinet work, and the painting and decorations for the saloons were completed in Germany, shipped to Glasgow, and built into the ship by German workmen. The Imperial mail steamers and the recent fast German passenger steamers have been fitted up with constantly increasing richness and luxuriousness, and this has developed a new industry which supplies excellent results from the designs of its own specialists, architects, and artists. Nearly every kind of larger equipment, for which British firms had gained a great reputation, and which was accordingly specified by the German shipping firms for whose account the vessels were building, was formerly delivered in the German yards; but, little by little, this industry has also passed to German manufacturers, who now supply steam capstans and cargo winches, steam steering gear, anchors and chains, etc., unless British articles have been specifically ordered. Many of the German specialties have already surpassed anything made in Great Britain of the same kind, as, for example, the hydraulic discharging and loading appliances and apparatus of C. Hoppe in Berlin, which have recently been introduced in the latest big freighters of the North German Lloyd; another example is afforded by the steam ranges and emigrant galley equipments of Becker & Ullmann in Berlin, which have even been sent to England for the outfitting of vessels built in England for German account. In this same line are the life boats built by O. Kirchhof, in Stralsund, for big passenger steamers, etc. Also nautical instruments, such as chronom-



IRON-FRAME CONSTRUCTION FOR AN ERECTING SHOP.

148 x 142 ft. Built by the Schiffs- & Maschinenbau-Aktien-Gesellschaft, Mannheim.

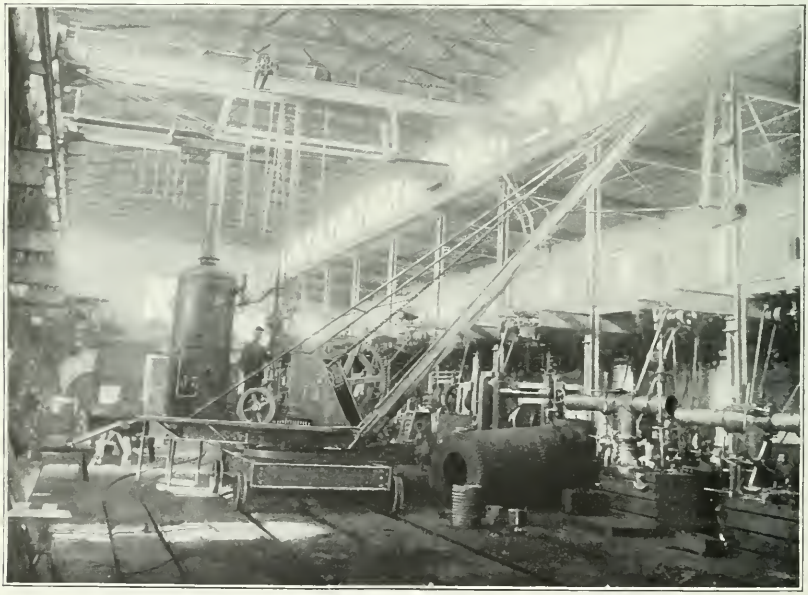
eters and compasses, are supplied by the opticians and specialists of Berlin, Hamburg, and Bremen, of such perfection that, according to the verdict of the Imperial Naval Testing Bureau in Hamburg, captains who formerly would have nothing but British manufactures now prefer the German articles. To mention all these articles would take too long, but it is sufficient to say that all are now made in Germany, and with few exceptions, are not now imported from England, except when certain articles are specially so ordered by captains or shipping firms.

ONE SPAN OF THE LINDENHOF BRIDGE AT MANNHEIM.
Another example of the range of work done in German ship-yards. The bridge is about 46 ft. wide, with spans of about 150 ft. Built by the Schiffs- & Maschinenbau-Aktien-Gesellschaft, Mannheim.

The inspection of merchant vessels during building, and afterwards during commission, in the interests of the insurance companies, has been undertaken in Germany for all German-built sailing vessels by the Bureau Veritas ever since its incorporation in 1828, and the requirements of this bureau were considered standard. Lloyd's Register was also occasionally made use of, and the German Lloyd organised in Germany for the same purpose could for a long time gain the confidence neither of insurance companies nor of ship owners. The building of the Imperial mail steamers was of the greatest importance for this institute, since the Imperial Chancellor Prince Bismarck ordered, in 1885, that these ships should be classed and registered in a German registry, and the only concern that could do this was the German Lloyd. In this manner it acquired some reputation with big ship owners, and others followed, so that to-day its registry has grown to a very important list.

The institute is well directed by its managers, at present Messrs. Ulrich and Middendorf, and its representatives, agents, and examiners are located in all of the larger harbours of the world, while in the iron regions it supervises the tests of iron and steel intended for shipbuilding purposes.

The German Lloyd has moreover been charged by the See-Berufsgenossenschaft (Sea-farers Union) with technical supervision over that part of the outfitting and equipping of vessels which may affect the health or lives of the crew, and the supervision is most beneficent, as it preserves the sailor to the highest degree possible from those dangers which are so peculiar to, and universal in, his hard calling.



STEAM JIB-CRANE OF 7-METRES RADIUS AND 4-TONS CAPACITY.
Installed in the erecting shop of the Mannheim ship-yards.

All these regulations and economic provisions, briefly enumerated and described, have helped to develop German shipping interests, and have succeeded in making it independent of all other nations. There has been also a constant and general co-operation between the German and foreign ship-builders, taking the form of the exchange of experience and knowledge, as well as of direct consultation and acquaintance of the specialists with one another, and of the founding of periodical literature, which is well established and constantly growing. Thus, the German naval constructors and mechanical engineers are no longer mere absorbers, as formerly, but they give as well as take. In this manner the way is prepared for international co-operation, which will surely lead to the highest pinnacle of perfection.

DREDGE AND EXCAVATOR FOR REMOVING ROCK.
Built in Mannheim for the regulation of the river Main.

All these details which have been enumerated at such length are the general answers to the qustion with which these articles opened; but perhaps it is well again to point out the main influences. On the one hand it is plainly to be perceived that the rapid and important development of ship-building in Germany is to be credited chiefly to the scientific training which the men, to-day in charge of it, had the favourable opportunity of acquiring. The study of the yards, plants, and practice abroad, especially in England, laid the foundation, and on this they built further by their own diligence and upright persistence, being mightily helped to reach the present height by the abundant facilities of the technical high schools.

On the other hand, one sees from the description of the various yards that here has been everywhere intense individual enterprise and energy; that the managers have worked hard, using every fair means to secure orders and to execute them with an eye to the future; as also that, during the period of apprenticeship, less attention was paid to present gain than to lasting reputation for splendid ships and engines.

Finally, all worked to attain the one great end. The Imperial Government helped the development by its own orders, its regulations and provisions for the home-built German ships, and by instructions to its representatives abroad to recommend on all occasions not only general German manufacturers but especially German-built ships, and, when occasion occurred, to help German firms, so far as its power reached, to secure contracts and to close deals.

All these endeavours and exertions were supported, and in the most active way fostered, by the intense interest which His Majesty the German Emperor manifests in everything belonging to the sea and German ship-building. Every new success is officially recognised and every worthy achievement is personally praised by him.

Let us close by wishing that international rivalry in ship-building may be yet further stimulated, to the furtherance of the ship-builder's art and the prosperity of nations. All naval engineers and mechanical engineers must endeavour to surpass one another in this respect. Germany, however, will never again lose the high position she has by her own efforts gained.

Boston and Colorado Smelter, Denver

THE EVOLUTION OF MINING AND ORE TREATMENT IN COLORADO.

By Thomas Tonge.

THE history of mining and ore treatment in Colorado, more particularly in recent years, is a remarkable instance of evolution of all lines. The chairman of a well-known London mining syndicate, which operates in various parts of the world, notably South Africa and West Australia, not long ago visited Colorado for the first time and, prior to leaving, informed me that he had not before realized the progress made and the great advantages possessed by Colorado in all the important factors of successful and profitable mining, such as transportation and ore-treatment facilities, effective inventions, appliances and methods and, last but not least, the skill and efficiency of the professional and practical men engaged.

Gold was first discovered in Colorado in 1859, but the district was then over 700 miles west of the nearest railroad, the intervening plains being infested by predatory Indians. It was not until 1870 that the first railroad, the Kansas Pacific, reached Denver. To-day, there are already over 5,000 miles of railroad within the boundary lines of Colorado and more are being constructed.

As the mining districts range from 8,000 to upwards of 13,000 feet above sea level, the railroads have had to overcome great engineering difficulties, as will be readily understood when it is stated that the Colorado Southern Railroad crosses the Continental Divide at Alpine Tunnel, at an altitude of 11,596 feet (the highest railroad point in America, except the railroad up Pike's Peak) and at Boreas at 11,470 feet. The Denver & Rio Grande Railroad at Fremont Pass is 11,328 feet and at Marshall Pass is 10,852 feet, and the Colorado Midland Railroad at the Busk-Ivanhoe Tunnel is 11,028 feet above sea level.

In recent years there has been a general reduction of railroad freight rates, on all smelting ore and concentrates, of from 25 to 50 per cent. So large a reduction in freight rates has naturally given a great impetus to the mining and has resulted in a vast increase of tonnage, notably of low-grade ores.

Supplementing the railroad facilities, hundreds of miles of wagon roads have been built connecting mines with the railroads, in many cases in place of the older trails for pack animals. In the case of comparatively short distances, where wagon roads were not feasible, in many cases aerial wire tramways (of which there are now dozens in the State), in other cases tunnels, and in still other cases, a combination of tunnel and tramway, have also taken the place of pack animals. One instance among many of the saving in cost thereby effected is found at the Smuggler-Union Group near Telluride, San Miguel County, where formerly all supplies had to be conveyed to the mine, and the ore carried down from the mine, on donkeys' backs and by a steep, narrow trail. This involved a total cost of $5 per ton on all the ore extracted. To-day, by means of a shaft, tunnel, and two tramways, each a mile in length, the same service is performed at a gross cost of less than 50 cents per ton of ore.

Numerous mining tunnels such as the Cowenhoven Tunnel at Aspen, the Revenue Tunnel near Ouray and others,* have effected great economy in operation, and, as a consequence, admitted of the mining and treatment of lower-grade ore at a profit.

TYPICAL WAGON ROAD IN THE ROCKY MOUNTAINS.

In the pre-railroad days, when Colorado was largely virgin ground, placer mining was practically the leading industry. A con-

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* These tunnels were described in "Some Important Mining Tunnels in Colorado," published in THE ENGINEERING MAGAZINE February, 1897.

TRAMWAY AT SMUGGLER-UNION GROUP, NEAR TELLURIDE.

servative estimate places at not less than $25,000,000 the value of the gold taken out of the placers of the streams in Colorado during the decade 1860-1870, the work being done by primitive "rockers," "short sluice boxes" and hand labor. After 1870 increased attention was given to lode mining, and placer mining was correspondingly neglected—all the more readily because, in many places, the very rich ground which alone could be profitably worked by crude methods and manual labor had been practically exhausted.

Within the last few years, however, placer mining in Colorado has entered upon a new era. Companies have entered with large capital, employing eminent engineers, using expensive hydraulic appliances and floating dredges; various patented "elevators" are also being utilized to overcome the difficulties, where there is not sufficient natural fall for the deposition of the "tailings" by gravity.

ALPINE TUNNEL, COLORADO SOUTHERN RAILROAD.
The highest railroad point in America. Altitude, 11.596 ft.

The gold ore first discovered in 1859 in veins or lodes in Colorado's pioneer mining district—Gilpin County—was "free milling"—readily extracted by the comparatively crude methods of arrastras and stamp and amalgamating mills of from five to ten stamps each. These were

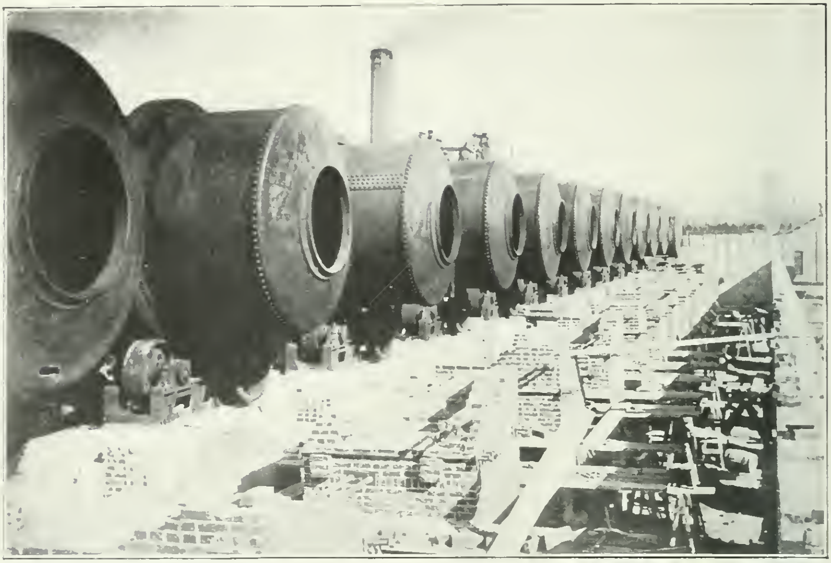
AERIAL TRAMWAY BETWEEN MINE AND MILL.
950 feet span; buckets 450 feet above the ground.

operated either by steam or water power, all the machinery being brought in wagons 600 miles across the plains. As depth was gained on the veins, the decomposed or oxidized ore was succeeded by ore of a refractory character, from which the stamp mills could only extract a small percentage of the known values; the bulk of the ore, though rich in gold, passed over the amalgam plates down through the sluices into the bed of the creek, being thereby lost. Even if the concentrates could have been saved, there was then no known process by which the gold contents could be extracted at a profit. From 1864 to 1867 numerous attempts were made to solve this problem, so vital to the district, but without success, and their failure brought the local mining industry to the verge of despair.

THE COLORADO-PHILADELPHIA CHLORINATION MILL, COLORADO CITY.

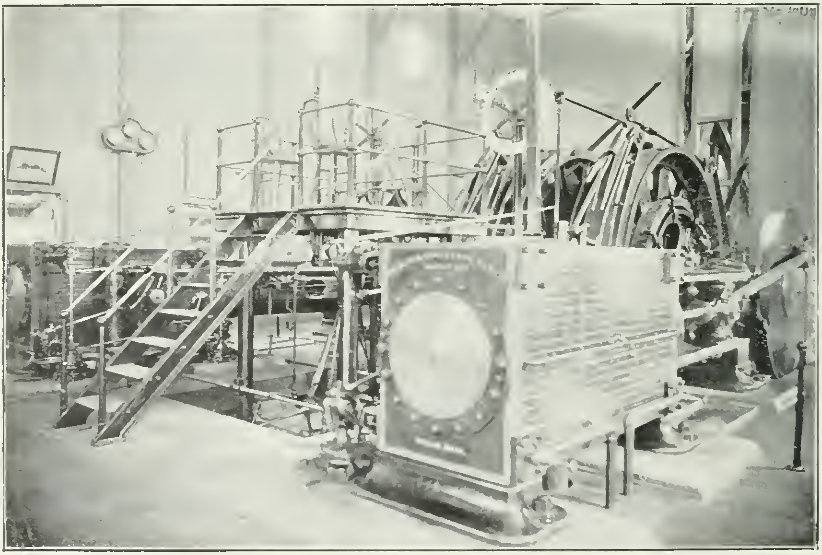
In 1867 there was erected at Black Hawk, Gilpin County, a smelting plant of 12-tons' daily capacity, consisting of one reverberatory and one calcining furnace, with the requisite machinery for crushing, pulverizing, etc. It commenced operations in January, 1868, and proved a success. The result was that the miners, finding a ready cash market for their ore, began to operate their abandoned claims and the mining industry of Colorado commenced a career which has ever since increased in magnitude and importance.

As illustrating the local conditions at the time of the commencement of operations by this pioneer smelter, it may be stated that every single fire-brick used in its construction cost one dollar, having to be brought by wagon about 600 miles from the nearest point on the Missouri River, and to that point by railroad from St. Louis; the iron cost 22 cents per pound; the pay of skilled labor was $8 per day, and of common labor $4 per day; and the charge for smelting ranged from



ROASTERS AT DENVER SMELTER.

Each smelter is 28 feet long by 8½ feet diameter, and takes a charge of 25 tons, nominal.

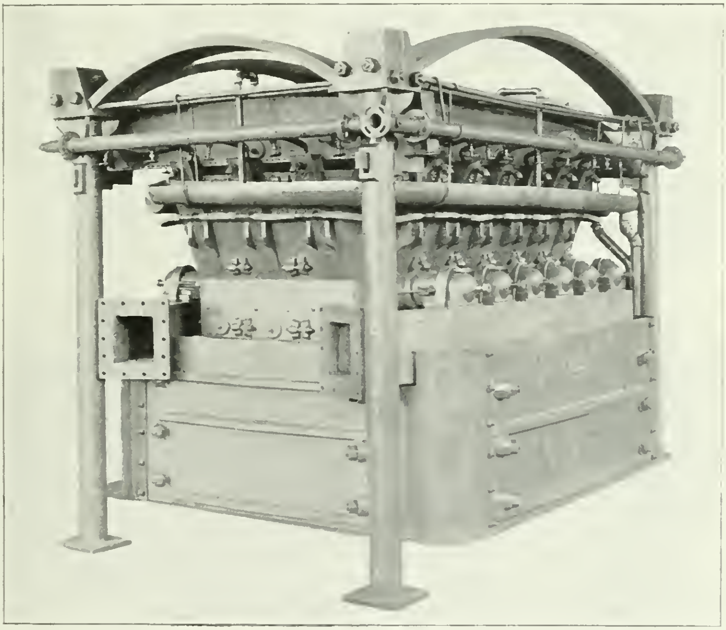


HOISTING PLANT OF THE GEYSER MINE, CUSTER COUNTY, COL.

The mine is 2,650 feet deep.

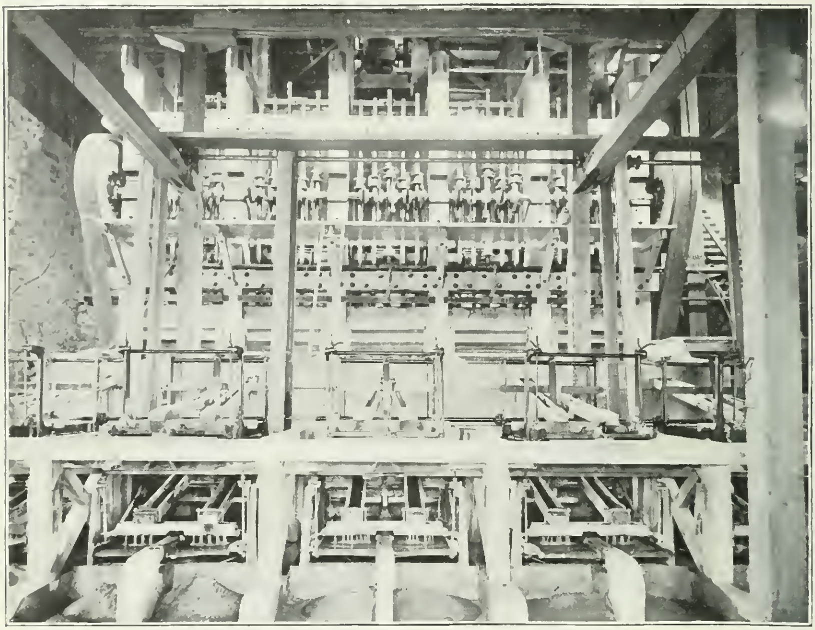
$20 to $45 per ton. There was no railroad nearer than the Missouri River, about 600 miles away; wagon transportation was high, as also were all the necessaries of life. Moreover, the "matte," the product of the plant, in the absence of any local means of separating or refining, had to be hauled to the Missouri River in wagons, thence by railroad to New York, and thence to Swansea, Wales, where it was separated and the gold, silver, and copper refined.

To-day, there are nine smelting plants in Colorado, viz., three in Denver, three in Pueblo, two in Leadville, and one in Durango, besides a zinc-lead smelter in Cañon City. Two of the plants refine their product, selling the gold to the Denver mint; the others ship their matte to allied eastern refineries. The aggregate daily capacity of the existing smelters is 4,500 tons and about 4,000 men are employed. Some of the plants are about to be materially increased in size and capacity, and new plants, including pyritic smelters, are in contemplation to meet the increased production, more particularly of low grade ores.

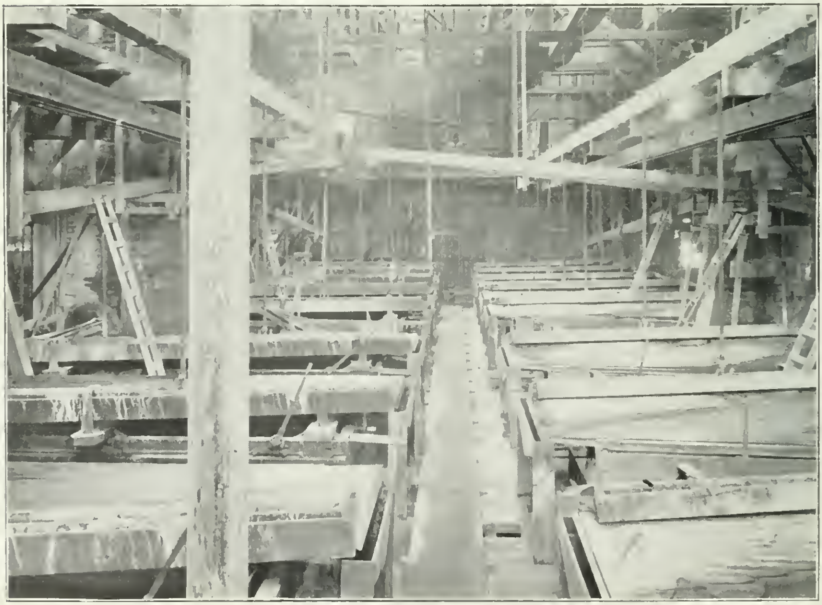


SMELTING FURNACE MADE IN DENVER AND EXPORTED TO THE ISLAND OF CELEBES, EAST INDIES.

To state it concisely: whereas, in 1871, after paying the cost of smelting, etc., the miner only received 65 per cent. of the value of the



STAMPS AND PLATES IN A COLORADO MILL.



MODERN CONCENTRATION TABLES.

ore, by the year 1889 he received 84 per cent. of the value, and the percentage has since been somewhat further increased. The average smelting charges in 1868 were at least $30 per ton, as against an average of about $4 per ton at the present time. In 1878 the average value of the ore treated in Colorado had to be about $100 per ton to leave a profit, as against the average value in 1899 of $25 per ton, including concentrates representing original crude ore reduced from six or seven tons to one ton.

The great improvements in smelting and the reduced charges have given a great impetus to other phases of ore treatment and to mining in general. There has been great improvement in the stamp mills also. A fifteen-stamp mill of to-day, with shallow mortars and rapid drop, treats more ore than the sixty-stamp mill, with deep mortars and slow drop, of the type which was in vogue in the "sixties." The usual capacity of the old-fashioned stamp mill was about one ton of ore per day per stamp, as they were then solely dependent on the stamp mill for the recovery of the gold values. The usual capacity of the modern stamp mill is from three to four tons of ore per day per stamp, the method being, (1):—to catch all the gold possible on the plates; (2):—to catch the maximum of the remaining gold on concentrating tables succeeding the stamps and plates; (3):—to ship the concentrates to the smelters.

At the Perigo Mine, Gilpin County, ore averaging as low as $3 per ton is mined and treated at a profit by means of a thirty-stamp mill, which saves a large percentage of the value, the tailings being concentrated and the concentrates shipped to the smelters. In Gilpin County alone there are thirty stamp mills containing a total of nearly one thousand stamps. In the vicinity of Telluride, San Miguel County, there are several large mills of one hundred stamps and upwards each. For some classes of ore, such as lead-silver ores, crushing rolls have superseded the stamp mill. Their superiority lies in not pulverising the ore too fine, and in reducing without "sliming;" the "slimes" resulting from stamping these ores carry off the values.

For every ton of ore rich enough to pay the cost of mining, wagon haul, railroad freight, and smelting charge and still leave a profit, there are at the very least ten tons of lower-grade ore, which could only be so treated at a decided loss, great or small. Such lower-grade ore is therefore concentrated, and in no branch of the mining industry in Colorado has greater progress been made, especially in recent years, than in concentration. The result is that an immense tonnage, formerly outside the range of profitable handling, is now being treated at a steady margin of profit. One instance among many may be mentioned. At Silverton a large concentrating mill is treating, at a comparatively handsome profit, crude ore the average gross value of which in gold, silver, lead, and copper does not exceed $5 per ton. This is not a mere by-product, but is the general character of by far the greater portion of the product of the mine. In this case, from four to seven tons of crude ore are reduced to one ton of concentrates, in which process less than 10 per cent. of the value is lost, the objectionable zinc is largely eliminated, the resulting concentrates carry an excess of iron (for which the smelter pays a premium), and, as the mine is within fifty miles by railroad from a smelter and a reasonable freight rate prevails, the concentrates are marketed at a substantial profit.

Generally speaking, ten years ago the highest saving of the values in sulphide ores by means of concentration was from 50 to 75 per cent., but at the present time it is as high as 90 per cent. By means of concentration, at many points in the State, large dumps of old mines and tailings of old mills, which accumulated during the last twenty or thirty years when no means existed for the profitable treatment of low-grade ore, are now being handled at substantial margin of profit, as also are large bodies of low-grade ore in the mines, formerly ignored for the same reason. The recent annual increase in the Colorado production of the precious and allied metals is owing, in no small degree, to the vast tonnage of low-grade ores rendered available by improved concentrating machinery and methods, operated at the minimum of cost and effecting the maximum of saving. In Clear Creek County alone, for the ores that do not go directly to the smelters, there are thirty-four plants for concentration and amalgamation.

Another important factor in the evolution of Colorado mining, as yet practically confined to the Cripple Creek district, has been the local establishment of cyanide and chlorination plants for the treatment of the lower-grade tellurium ores. The present condition of affairs is that all Cripple Creek ore worth $40 per ton and upwards goes to the smelters at Denver and Pueblo, being treated at a charge of from $10 to $14 per ton, $20 per ounce being paid for the gold. The ore ranging in value from $10 to $40 per ton goes to the cyanide and chlorination plants at Florence and Colorado City, the treating charge ranging from $6 to $10 per ton. All ore averaging in value less than $10 per ton—of which many thousands of tons have been produced in the course of mining richer ore, and now form great dumps, and of which much larger quantities remain in the mines—is not yet within the range of profitable treatment by any existing plant and awaits the advent of some new process.

Another important factor of the last few years has been the utilization of the mountain streams, in some cases, and of cheap fuel in others, for the generation of electricity and the utilization of such electricity for power and lighting purposes, at mines at so high altitudes and accessible only by trails or wagon roads so steep as unavoidably make fuel for steam power at such mines almost prohibitive. The Silver Lake group near Silverton is at an altitude of from 12,000 to upwards of 13,000 feet. The waters of a mountain stream are used in a three-phase power plant at an altitude of about 9,000 feet to generate 400 h.p., which is transmitted by wire 11,000 feet and 22,000 feet respectively to the mines, and there runs seventeen motors occupied in various kinds of work, ranging from 1 h.p. to 100 h.p. each. But for this comparatively cheap power the production of the mine would be restricted.

Another factor, equally important, has been the utilization of compressed air for the operation of machine drills and the great improvement in the drills themselves. The earlier type of machine drill would do as much work as five or six men using hand drills, but the more recent types of drill do this and more, at a saving of 50 per cent. in fuel, as against their predecessors. Several hundreds of the latest-made drills have gone into use within the last eighteen months. The diamond drill is another comparatively recent auxiliary of the mining industry, being utilized for prospecting purposes at a fraction of the expense of sinking a shaft to a similar depth. In a recent case it was most successfully and economically used to tap, from a tunnel, the flooded lower workings of deep surface shafts, which the tunnel was designed to cut for more economical future mining operations.

Most marked also have been the improvements in hoisting plants from the primitive hand windlass, horse-whim, and small engines of years ago up to the latest and most modern machinery, operated by the minimum of steam with consequent saving of fuel. The deepest mine in Colorado, the Geyser in Custer County, is 2,650 feet deep. It has 28 x 72 engines, double reels for 4,000 feet of flat wire rope, ⅝-in. x 7 in., capacity 30,000 lbs. at 100 lbs. boiler pressure, speed 2,200 feet per minute, weight 400,000 pounds. Each single reel of 2,865 feet of this rope weighs about 24,000 lbs.

In the matter of mine pumps equal progress has been made from the baling by bucket or primitive pumps of thirty years ago to the wonderful sinking and station pumps of to-day. The Argentum-

Juniata Mine, Aspen, has triple-expansion pumps, lifting 800 gals. per minute 1,000 feet, and the Ibex Mine, Leadville, Portland Mine, Cripple Creek, and a number of others have similar powerful pumps.

The Leadville Pumping Association, consisting of the owners of a number of adjoining extensive mines which had been temporarily closed, was organized for the purpose of unwatering the district covered by such properties, comprising an aggregate of many miles of deep underground workings. Two shafts were equipped with two pumps each, of an aggregate capacity of over 3,000 gals. per minute. Pumping was commenced 20th October, 1898, and continued practically without intermission until June, 1899, before the mines were sufficiently cleared to admit of the resumption of mining operations.

With all the local improvement in mining and ore-treatment machinery and appliances, Denver has become a great mining machinery centre, shipping not merely to all the mining districts from Alaska to Panama, but increasingly to other continents. For instance, three silver-lead smelters of Denver manufacture were recently exported—one to the island of Celebes in the Dutch East Indies, another to Tasmania, and a third to England. Concentrating machines, machine drills, and other apparatus of the most modern character of Denver manufacture are in increasing demand throughout the mining districts of the United States and other countries. The reason is simple. For nearly forty years the manufacturer of mining and ore-treatment machinery in Denver has been in close touch with the practical miner and mill-man, and the present perfection of locally-invented, or locally-developed and locally-manufactured, machinery and appliances is the natural result of their joint practical experience and desire to meet requirements. Moreover, Colorado and the adjoining States contain practically almost every variety of ore and the local manufacturers have been called upon to co-operate in the solution of almost every kind of metallurgical problem. All the before mentioned evolution tends to reduce cost of production and increased margin of profit. On such lines, the element of chance is reduced to a minimum, and mining, so far from being a gambling venture, as has too often been the case with the inexperienced and incautious, becomes a business enterprise as legitimate as the cotton, or wool or iron-manufacturing industries. Where mining has been entered upon and conducted on a conservative and common-sense basis, free from the peculiar practices too often connected with promotion, flotation, and stock-exchange manipulation, it shows greater average profits and less average losses than investments in railroads or banks.

EDITORIAL COMMENT

The unification which is resulting from the friendly competition between Great Britain and the United States in matters mechanical is well illustrated in the international yacht races, or rather in the construction of the yachts themselves. At the times of former races much interest was expressed in scientific and engineering circles as to relative influences of different forms and principles of construction upon the speed of such craft, and the theoretical principles involved occasionally formed the subject of interested discussion. With each succeeding race, however, the lines of the competing boats have approached each other more and more nearly, until on the present occasion the interest in the races seems to be confined almost entirely to a comparison of seamanship, the two yachts appearing to be so similar in design and construction as to decide nothing except the fact that each designer has profited by experience to select the good points of his opponent and abandon those which he has found defective.

A similar unification is becoming more and more apparent in other branches of construction, and it appears almost certain that before long the distinction of nationality in tool and machine design will have passed into the limbo of the forgotten, and that the best points of the designers of both nations will be merged into work which must be superior to that which has preceded. The laws of evolution hold good for all products of industry, and the survival of the fittest must be expected as truly for a lathe or a locomotive as for a mollusk or a man.

* * *

In these days of many journals devoted to all branches of technical and professional work, it is impossible for any man to keep up with the record of progress by his own unaided efforts, and indeed most men have given up the effort. Some cling to a few favorite periodicals, others have abandoned all attempts, and very many, without any premeditated plan, simply take up what they can, and gather, hit or miss, what may casually come before them.

All this is very unsatisfactory, and for a number of years attempts have been made to gather, classify, and abstract the mass of current information contained in periodical literature of various kinds, and the degree of success has been such that there are now a number of index systems and publications in existence, all doing good work in their various fields and all bearing evidence of the power and value of co-operation.

* * *

About the earliest attempt to make a published index of engineering literature was that initiated in 1884 by Professor J. B. Johnson, of St. Louis, who started a monthly index in connection with the *Journal of Associated Engineering Societies.* This index, conducted under many difficulties, and in connection with arduous duties of professional and educational work, grew to be an important feature of the collective transactions of the several technical societies which form the Association, and in 1891 a collected volume of the work produced up to that date was published and found ready and valued acceptance.

* * *

At the beginning of 1896 the index published by the *Journal of Associated Engineering Societies* was discontinued in favor of that prepared by THE ENGINEERING MAGAZINE, and in the same year a second volume appeared, bringing the work of Professor Johnson and his associates up to date, since which time the index appearing monthly in THE ENGINEERING MAGAZINE has occupied its special field alone.

* * *

During the past few years interest in indexing technical and scientific periodical literature has been still more actively aroused. At the beginning of 1898 a new publication entitled *Science Abstracts* was started in London, devoted entirely to the indexing of current articles of scientific interest and value. This index, which is under the able direction of Mr. James Swinburne, assisted by a corps of abstractors, is devoted entirely to the subjects of physics and electrical engineering, and makes no attempt to cover the entire field, but for thoroughness of work and fullness of its abstracts it is worthy of highest praise. Following this English work comes a new French publication, *Le Mois Scientifique et Industriel,* conceived on much the same lines as the *Science Abstracts,* but extending its scope over a much wider field, including nearly every branch of applied science.

Besides these special periodicals many of the leading technical journals on the Continent publish at intervals index-sheets, more or less complete, of important articles of the day, and among the more notable of these may be mentioned the lists appearing in the *Zeitschrift des Vereines deutscher Ingenieure* and in *Glaser's Annalen* in Germany, and in *Le Génie Civil* and *La Revue Technique* in France. Some of the professional societies are also doing good work in this direction, notably the Institution of Civil Engineers, and the Iron and Steel Institute in England, and the American Society of Civil Engineers in New York. It is also understood that the Royal Society is making plans for a general indexing of current literature in the domain of pure science, while at the present time the International Institute of Bibliography at Brussels and the Concilium Bibliographicum at Zurich are vigorously attacking the whole field of current literature.

All this activity speaks well for the progress of methodical research, and the reproach can no longer be made against periodical literature that it is too ephemeral to be of value and that any faint impression which a writer may make is soon to vanish. In no line of work is the strength of union more apparent than in the effect of these concentrated efforts at classification and indexing of the records of the useful work of the world, and by such records men of action everywhere may well be seconded in their efforts to know "what to do and how to do it" by learning "what has been done and who did it."

REVIEW OF THE BRITISH PRESS

The Consumption of Water in Cities.

THERE has been much talk at various times about the waste of water by the consumers in towns and cities, and comparative tables are given to show what the proper consumption per head should really be. The difficulty of making any general rule for places in which the conditions are altogether different is well set forth in a communication to a recent issue of the *Journal of Gas Lighting*, and incidentally some very interesting points are brought out.

The words "rate per head per day" have really very little meaning, and convey but an illusory idea, when comparing the statistics of one town with another, and unless the circumstances and conditions are fully ascertained very misleading conclusions may be drawn. One town may have a record of only 20 gallons per head per day for all purposes, but examination would reveal that there are no gardens to be watered, that only half of the houses have water-closets, and that there are few baths or hot-water fittings.

"Conclusions based on such erroneous, hap-hazard statements, and manipulated by councillors who have not been educated in water-supply, can never lead to correct or useful results. It is well to compare such places with a modern seaside resort, where three-fourths of the houses have gardens for which the hose is used freely, where every house has one, and probably two closets and a bath (sometimes two), and where the town councillors in their wisdom advise a three-gallon, instead of a two-gallon flush, without any knowledge of the requirements, or any idea as to what an enormous output of water this unnecessary extra gallon amounts to.

"In different towns the consumption of water per head often varies to the extent of three times the average. This can always be accounted for. It is measured by the wants of the people, the facilities afforded for using the water, and the different habits of the population. Comparisons cannot be made even with towns of similar size and number of inhabitants; inasmuch as the rules and regulations are entirely different."

When the introduction of waste meters shows a reduction in the output it is usually found that no systematic attempt had previously been made to stop the waste. In other places the taps are washered gratis, and a rigid inspection is maintained, and the waste is reduced to a point where little or no economy will be produced by the use of meters. The rate per head per day is by no means uniform for the same place.

"Take the town of Richmond, which has a supply of 27 gallons per head per day for nine months in the year, while during the summer months 42 gallons are absolutely necessary; this being a town having a number of gardens on which hose is used." Other places are cited in which the consumption ranges from 24 to 42 gallons, but in every case there is some good reason for the difference.

"The difference in the consumption of water per day per head of the population where efficient and inefficient regulations are carried out and enforced by law, ranges from 20 gallons in the former to 80 gallons and upwards in the latter case. Therefore it is of the first importance that adequate rules and regulations should be enforced, and proper measuring apparatus—such as the Venturi meter—fixed on all outlet mains at the source of supply."

While these points are doubtless well made, and while the impossibility of comparing various cities under manifestly different conditions must be admitted, yet the consumption per head per day may at least be taken as a rough guide. When 80 gallons per head per day is considered evidence of waste and neglect, what shall we say to a consumption of 160 gallons and more, as we find recorded of some American cities? Under such conditions of waste there can be no wonder that it is impossible to furnish a reasonably healthful supply, or that the task of installing an adequate filter plant should become one of appalling magnitude. While it may not be possible to say that the normal daily consumption per head should be a definite quantity yet it may at least be placed between certain reasonable limits, and, while good health may demand that the actual consumption should not fall below 35 to 40 gallons, yet certainly it is wasteful extravagance to allow it to pass the 100 gallon mark.

Electrical Engineers in Switzerland.

THE foreign reunion of the Institution of Electrical Engineers, which has recently taken place in Switzerland, proved to be a success in many ways, and from a review in the pages of *Engineering* we make some notes upon the progress and features of the excursion.

Switzerland has come to be so generally recognised as the centre of power generation and electrical distribution of Europe, that the wisdom of making it the place of an excursion of investigation must be conceded. Most of the Swiss plants include hydraulic work in the form of dams, conduits, tunnels, etc., as well as installations of turbines of the most modern design, driving powerful generators from which the current is distributed to many varied industries. Nearly all the machinery used in Switzerland is made within her own borders and the generation, transmission, and utilisation of natural sources of power seem to form a large portion of the industry of the country.

Overhead wires are the rule in Switzerland, and doubtless one of the facts which has assisted in the development of electrical power distribution has been the facility with which conductors have been allowed. High tension mains are allowed to traverse the country in all directions, and stringent legislation has been enacted for their protection, but it appears to be only a question of time when the multiplication of wires and the introduction of still higher pressures will compel some other means of dealing with the question of transmission.

The high reputation of the Swiss machine works, and the extent to which their products are used in the form of turbines, engines, and electrical machinery in the power plants rendered visits to the establishments an important and valuable portion of the meetings, while the inspection of the tramways, mountain rack-railways, and other transport applications completed a survey of the most active portions of continental Europe, so far as electrical work is concerned.

Some of the points upon which comments were made were those which would naturally attract the attention of foreigners. The peculiar arrangement of working hours in Switzerland, by which no work is done between the hours of 12 and 2 o'clock, is a handicap upon commercial efficiency, while the fact that some of the largest hydraulic power stations have had to be equipped with auxiliary steam plant for reserve in time of scarcity of water appeared to show that the "white coal" was not always to be depended upon.

On the whole, however, the visit to Switzerland was both interesting and instructive, and the many industries there successfully operated by electrical means should prove a further incentive to the extension of similar plants in Great Britain.

Large Cargo Steamers.

THE transformations which have been wrought during the past few years in the Atlantic carrying trade are well set forth in the paper read before the Institute of Naval Architects by Mr. G. B. Hunter upon the subject of large cargo steamers.

The growth which has taken place in this respect is best shown by reference to a table presented in Mr. Hunter's paper in which it appears that in 1891 the largest cargo steamer of the year was the Chancellor, of 4,753 gross tons, from which time there has been practically a steady growth. In 1896 the Milwaukee, of 7,317 tons headed the list, and in 1898 the Ultonia, of 8,056 tons, while at the present time the Invernia, of 13,200 tons, is under construction.

Without discussing any particular steamship Mr. Hunter proceeded to outline his idea of the Atlantic cargo steamer as she will be built in the immediate future. Such a vessel, for carrying large cargoes across the Atlantic economically and safely on a moderate draught might be designed to carry not less than 12,000 tons deadweight, with cubic capacity for 20,000 tons of cargo at 40 cubic feet per ton, and

1,000 tons of fuel. This would require dimensions approximately as follows: Length between perpendiculars, 500 feet; breadth, 60 feet; moulded, 36 feet to main deck, 44 feet to shelter deck; draught of water, loaded, about 27 feet 6 inches.

Since the heavy cargoes are practically carried only one way, viz., from the United States, there should be provision for sufficient water ballast for the outward voyage assuming no cargo. This would require not less than 4,000 to 4,500 tons of water ballast for a 12,000 ton vessel, distributed in the double bottoms, and in deep and in 'tween deck tanks. Large peak tanks are considered objectionable, as promoting pitching, vibrations, and uneasy motions, while no small portion of the strains on the machinery is caused by the too common custom of providing insufficient ballast when without cargo.

The question of powering such a vessel is not at present a difficult one, and is governed mainly by commercial considerations. 'Large steamers are more easy and economical to drive than small ones. When they run in a regular line in turn with smaller steamers it is desirable for them to be fast enough to make up on the voyage for the longer time they take in port to load and discharge than the smaller steamers."

Many of the lines running to the East carry cargo at only about 9 knots, but in the head winds of the Atlantic somewhat greater power is desirable, and 11 to 12 knots is more nearly the rule. Three-cylinder triple expansion engines, with single ended boilers working at 180 to 200 pounds, with forced or induced draft is about as economical and durable an equipment as can be employed, and with skillful handling there appears to be no good reason why forced draft boilers should be short-lived.

The principal weakness which has developed in steamships is in the matter of shafting, and it is recorded in Lloyd's List that 198 steamers were disabled in 1898 through broken shafts, and 53 similar accidents have been reported for the first three months of the present year. While a portion of these cases may be attributed to insufficient ballasting, yet this can account for only a portion of them, and there is a growing tendency to advocate the use of heavier shafting, Lloyd's having already increased their requirements for propeller shafts about 16 per cent. with a further increase under consideration. Mr. Hunter, however, goes much further than this and advocates, for large single-screw vessels for Atlantic service, an increase in strength of propeller shafts of 100 per cent. above the present rules.

The use of twin screws and the accompanying duplication of power machinery is recommended, not only because of the greater efficiency of such an arrangement, but because of the insurance thus obtained against loss from breakdowns. The original cost is doubtless greater, but the advantages are sufficient to compensate for this when the ship itself may be worth £300,000 and there are 10,000 to 12,000 tons of valuable cargo aboard.

There seems to be little doubt that during the next 10 years there will be many of these large cargo steamers built for trade in all parts of the world, the advantages of cost and operation in comparison with the capacity amply warranting their general adoption.

The Progress of Steam Navigation.

The address of Sir William White, President of the mechanical science section of the British Association, consists of a review of the progress of steam navigation, and coming from one who has played such an important part in the progress which has been made in that branch of applied science, his remarks are filled with interest and meaning.

After calling attention to the variety of conditions which must be met in steamship design, it is shown that in all types there is one common requirement, the attainment of a specified speed, and that there has been at the same time a continuous demand for higher speed. This element of speed is always intimately related with the elements of load, power, and fuel supply, and the two last have to be determined in each case. The nature of these relations is determined by the character of the service to be performed by the vessel, and by the crucial question, Will it pay?

The manner in which the controlling

conditions of steamship construction have been met is best illustrated by a study of the progress which has been made in the past, and this Sir William White gives in some detail, from 1840 down to the present time. It is impossible here to give his historical resumé of the leading vessels constructed since that date, but the summary is well worth studying, especially as it shows the close interdependence which exists between the shipbuilder and the mechanical engineer in the work of engine and boiler design.

"Sixty years of continuous effort and strenuous competition on the great ocean ferry may be summarised in the following statement. Speed has been increased from 8½ to 22½ knots; the time on the voyage has been reduced to about 38 per cent. of what it was in 1840. Ships have been more than trebled in length, about doubled in breadth, and increased ten-fold in displacement. The engine power has been made forty times as great. The ratio of horse power to the weight driven has been increased fourfold. The rate of coal consumption—measured per horse power per hour—is now only about one-third what it was in 1840. To drive 2,000 tons weight across the Atlantic at a speed of 8½ knots, about 550 tons of coal were then burnt; now, to drive 20,000 tons across at 22 knots, about 3,000 tons are burnt. With the low pressure of steam, and heavy, slow-moving paddle engines of 1840, each ton weight of machinery, boilers, etc., produced only about 2 horse power. With modern twin-screw engines and high steam pressure, each ton weight of propelling apparatus produces from 6 to 7 horse power. Had the old rate of coal consumption continued, instead of 3,000 tons of coal, 9,000 tons would have been required for a voyage at 22 knots. Had the engines been proportionately as heavy as those in use sixty years ago they would have weighed about 14,000 tons. In other words, machinery, boilers, and coals would have exceeded in weight the total weight of the Campania as she floats to-day. There could not be a more striking illustration than this of the close relation between improvements in marine engineering and the development of steam navigation at high speeds."

After considering the corresponding advance which has been made in cargo steamers, war ships, torpedo boats, destroyers, and other special types, Sir William White proceeds to examine the progress which appears since 1840 in detailed portions of vessels and propelling equipment. In the motive power the principal improvements have come from the generation of much higher pressures of steam than were formerly possible, and from the improvements in the engines involved in the application of such high pressures.

The old flue boilers, with their flat, stayed surfaces, long ago gave way to the cylindrical boiler, which with its corrugated furnaces, has made working pressures of 160 to 180 pounds practicable, and these pressures have in turn led to the use of multiple expansion engines, and the consequent economy in steam consumption which forms so large a portion of the advance in marine engineering. The higher pressures which are still demanded have been attained by the use of water-tube boilers, and in view of the agitation against such boilers which is being conducted in certain quarters it is interesting to note what Sir William White has to say on that important matter.

"The use of water-tube boilers in recent cruisers and battleships of the Royal Navy has resulted in saving one-third of the weight necessary with cylindrical boilers of the ordinary type to obtain the same power, with natural draught in the stokeholds. Differences of opinion prevail as to the policy of adopting particular types of water-tube boilers; but the weight of opinion is distinctly in favour of some type of water-tube boiler in association with the high steam pressures now in use."

In connection with the gain made by the use of high pressure steam the advantages of higher rotative speeds must also be considered, and in this connection the steam turbine appears to be the important motor of the present and immediate future. It is anticipated that the use of turbo-motors will enable the weights now required for the engines, shafting, and propellers of Atlantic liners to be reduced one-half, while at the same time most, if not all of the injurious and wasteful action of vibration due to unbalanced reciprocating parts will be prevented.

The Glasgow Tramway Engines.

THE discussion produced by the circumstances attending the award of the contract for the steam engines for the Glasgow tramways possesses more than a mere passing interest, not so much for the details of that particular instance as for the light which it throws upon the differences in practice and opinions concerning steam engineering in Great Britain and the United States. It was quite natural that the original award of the contract to an American firm should have called forth expressions of disapproval, even though that firm had already received contracts for a number of engines for similar service in England. The fact that the objections took the form of adverse criticism of the proposed design, however, instead of the mere expression of a desire to have the work done at home, renders the matter one of engineering interest instead of local feeling.

Much has been published in various journals upon this subject, and from the columns of the *Engineer,* from editorials and correspondence, an excellent view of general opinion may be gathered. The controversy has been settled for the time by the award of one-half the work to the American firm and the other half to a British establishment, so that the practical result may well be left to settle itself, but leaving all matters of feeling aside the engineering points of the discussion will bear examining.

In the first place it is to be noted that only a few leading dimensions were given in connection with the specifications, and these were not made obligatory, as it was desired by the committee to leave the manufacturers as free as practicable to follow their own designs. At the same time it must be remembered that the engineer by whom the specifications were drawn, Mr. H. F. Parshall, although a member of the Institution of Civil Engineers, and long a resident and practitioner in England, is an American by birth and training, and has gained his experience in tramway machinery in the midst of the development of the numerous great American systems. The fact that Mr. Parshall, with this experience and with his unquestioned ability, did not see fit to draw up a detailed design for the engines, and require each bidder to conform precisely to identical details of construction, must be taken to mean that he desired to relieve the bidders from that close bondage to the restrictions of the consulting engineer about which so much has been heard of late. It is generally admitted that the freedom in design and construction which is permitted in America has had much to do with the development of fit types of machines for various lines of work, and to permit each builder to do the work to his best advantage, and this innovation in connection with such an important contract as that of the Glasgow tramway engines should be welcomed on all sides.

The real difficulty in this especial case appears to be the fact that up to the present time no engines of such size for this kind of work had been constructed in England, and experience in this particular line was lacking. It has been said that much larger marine engines have been most successfully designed and built in England, which is doubtless true, and it is well-known that British marine practice forms the foundation not only for American designers in that line, but also for those of other countries, but marine practice is not stationary power-house practice, and it is sound engineering to take the best wherever it can be found.

Of course it does not at all follow that successful and satisfactory engines for tramway service cannot be designed on other lines than those which have been developed in America, but to introduce a modified or different type in connection with such an important undertaking as that at Glasgow could hardly be regarded as other than a rather risky experiment. As a correspondent to the *Engineer* pointed out, the real difficulty in England has been the repressive influence of municipal authority, which, doing nothing itself, would allow others to do nothing, and so hampered the work of development in which the most valuable experience would certainly have been gained.

The principal point of criticism of the American designs is the large diameter of the shaft, especially of the shaft bearings, and the great weight and cost of the shaft as specified by Mr. Parshall had much to do with the amount of the bids. It is not probable, however, that an excessive size would have been adopted in America had not previous experience with lighter shafts been unsatisfactory, and while disproportion is undesirable it is well to err on the side of strength and stiffness. The whole tendency of American practice has been toward moderate rotative speeds and massive parts, and when one remembers that the general criticism of American machinery in the past has been of its apparent lightness, this change to greater weight and strength must be considered as a concession to British ideas.

The controversy has not been without value in bringing out ideas and opinions which must bear fruit in future cases, and the outcome of the Glasgow incident will be watched with much interest on both sides of the Atlantic.

By-Product Coke Ovens.

THE importance of preventing waste and recovering all possible by-products in industrial technology is leading to the extended introduction of by-product coke ovens of various kinds, and the success which has attended such installations renders detailed information interesting. A recent issue of the *Colliery Guardian* discusses the working installations of Semet-Solvay coke ovens which have been made in various parts of England and shows the decided advantages which have attended their operation.

Although there has been much prejudice in England against the recovery oven, yet it has taken an excellent hold there, there being 370 ovens n operation with a product of more than 400,000 tons of coke per year, England coming second only to Belgium in this respect. "The coals of each country differ very considerably, and this has been one of the difficulties in the introduction of the recovery oven into England. Continental coal seems to have been more adaptable to the new process than English coal. Could we fix the quality of the coke by the percentage of carbon in the original coal, there can be no doubt that long before this, the recovery oven would have made far greater progress in England than it has done."

There have been no figures made public by which the comparative performance of beehive and recovery ovens in England can be obtained, but from trials made in the United States it appears that although the cost of the by-product oven is about five times that of a beehive oven, yet the total output of the former is so much greater that the cost per ton of coke produced is only about three-fourths as much for the recovery oven as for the older type. The value of products of the by-product oven is given as $14.68 per day, as against 93 cts. for the beehive, this not including the gas, which was not taken into account in either case.

There appears to be no reason why as high economies may not be obtained in England and figures given for English coals show that the market value of the by-products from a given quantity of coal is decidedly greater than that of the coke.

The products generally recovered by Semet-Solvay ovens are tar, ammonia, and benzine. The tar is either sold as made or subjected to a fractional distillation, the ammonia is converted into sulphate of ammonia, for which there is a regular market, and the benzine is treated and rectified into naphtha and benzol and finds many applications. In addition to these products, however, the gas from the coke ovens is now found to be a most valuable product.

The first portion of the gaseous distillate is rich in illuminants and may be collected in a special holder for use in illuminating purposes, while the remaining portion is almost equally valuable as a fuel gas, being either burned under boilers or preferably used directly in gas engines, for which latter purpose its high calorific power renders it eminently adapted.

In view of the large portion of value in the coal which goes to waste when recovery ovens are not used it certainly appears that every effort should be made to overcome any objections which may exist as to their adaptability to all cases. A study of the influence of the method of coking upon the character of the product should render it possible so to modify the operation as to permit the valuable by-products to be utilised in all cases, and yet retain the highest value in the coke as well.

REVIEW OF THE CONTINENTAL PRESS

Mechanical Traction for Canals.

WITH the general interest which exists in the development of internal waterways in central Europe there has also arisen an activity in devising substitutes for animal traction. The entire subject of mechanical traction in connection with internal navigation is treated exhaustively in a paper by M. Galliot in the *Revue de Mécanique*, while the application of electric traction to canals is discussed at length in a paper in the *Elektrotechnische Zeitschrift* by Herr G. Klingenberg.

As a matter of fact, the present system of animal traction is most primitive, there having been little or no improvement since the most remote times, and although nearly a century has elapsed since the application of steam power to navigation, we still see boats hauled along the canals by horses, mules, and even by men.

It is largely on this account that canal navigation has been regarded by some as a system of transport which is gradually becoming obsolete, and which is destined to be superseded entirely by railways; but when we consider that in many cases the canals have been acquired by the railways in order to divert the traffic, and consider the utter neglect which has until recently been shown toward the older method of transport, we see how mistaken an opinion may be when it is based upon such peculiar conditions.

Apart from any system which merely involves the use of steam tow-boats, the methods which have been seriously applied to canal service may be divided into three classes; (1) screw propellers, fitted to the boats themselves, (2) chain or cable towage, operating by power-driven drums on the boats, and (3) electrical towing machines running on the tow-path or on a track by the canal, and hauling the boat by tow line.

The use of screw propulsion is one which naturally suggests itself when the question is brought to the notice of the general observer, but the peculiar conditions attending canal transport have rendered it difficult to make a satisfactory solution of the problem in this manner. In the first place it is very desirable that no important change be made in the construction of the thousands of existing canal boats, and so it is hardly practicable to install an entire engine, boiler, and screw equipment upon each boat, especially since this would detract materially from the carrying capacity. This difficulty has been met by placing a motor in a sort of a box rudder and connecting it directly with a propeller projecting from the rudder. The high speed of the electric motor enables a small propeller to be used, and the electric current can either be taken from a feed wire running along the bank, or be produced by a small engine and generator standing on the deck of the boat.

While the idea of placing the power in the rudder, first suggested by M. Trouvé, avoids the cutting of the boat and renders the old boats available, yet it possesses the disadvantage of so lengthening the boat as to interfere with the passage through locks, and in many cases the time lost by unshipping and re-shipping the rudder is sufficient to condemn the apparatus. The clumsy shape of the stern of the boats as now made also renders it difficult to attain speed, owing to the wake which causes the propeller to draw air and lose in power and efficiency.

The use of fixed cables or chains in connection with power-driven drums on the boats, is an very old idea, and has been used with some success, especially on the Rhine, where heavy chain-towage is still in regular operation; but this system is hardly applicable to the great bulk of canal transport, and must always be limited to motor boats hauling heavy trains of canal barges behind them. Few if any installations of this kind are now being made, and they are very unlikely to come into future extended use.

In all probability the third method, that of haulage by some form of travelling machine running along the bank, offers the best prospect of success, both from a mechanical and a commercial point of view. This method includes not only hauling machines acting by direct towage, but also running cables to which the boats may be connected and disconnected. Running cables have been a subject of experiment since 1869, when a patent was taken out by MM. Troll and Mercier, and since then numerous modifications have been made, principally in connection with the supports and grips, but in spite of the perfection to which these details have been brought, this form of canal towage has not been found acceptable.

Towing machines running along the path have been quite successfully mechanically, and several forms of these are now in use. The first of this kind dates back to 1839 and was devised by M. Larmanjat. In this case a steam traction engine was used, there being a single rail to act as a guide while the weight of the machine was carried by large wheels running on the tow path, but the cost of operation at that early date prevented the system from coming into use.

The same idea, using electricity, has now been revived in France by M. Galliot himself, and in Germany by Siemens & Halske, the principal difference between the two systems being that the first uses a machine which runs on the ordinary tow path, while the latter requires a narrow-gauge railway by the side of the canal. Both of these systems are now in actual use, that of M. Galliot being introduced by MM. Denèfle & Cie on the canals of the Aire and the Deule, in France, and that of Siemens & Halske on the Finow Kanal in Prussia. In the first case there is a separate machine for each boat, the whole apparatus weighing about two tons, and being capable of exerting a uniform tractive power of 1,000 pounds, or an emergency pull of a ton. The machine is controlled by an operator who rides upon it and steers it as well. The principal objection which was urged against a machine running upon the tow path was the possible damage to the road way, but with the wide rimmed wheels and a properly made road, it is found that there is less injury to the path by the machines than from the horses. Since the power is taken by a trolley pole from an overhead wire there is no interference whatever with the path for animal traction, and the system can be gradually introduced in connection with the older plant, and no change whatever is needed in the boats.

The Siemens & Halske system is intended for hauling trains of barges, and is intended to supplant horse traction entirely, and while it will doubtless be an entire mechanical success it is much more costly in installation.

The crucial question of commercial economy has yet to be settled, and cannot be decided until after a prolonged trial under actual operative conditions, but there is every reason to believe that if success is attained it will be along the lines of the last two systems.

The Ventilation of Tunnels.

The development of railway construction has caused the construction of tunnels and subways to become a most important department of the work of the engineer, and the increasing use which is made of such passages by railway trains has drawn attention more and more to the necessity of providing sufficient ventilation.

When a tunnel is of but moderate length and is traversed by but few trains the natural ventilation due to a difference in pressure of the atmosphere at the two extremities or to a difference in temperature between the interior and exterior, is sufficient to change the air frequently enough to prevent serious annoyance. When, however, there is not a sufficient natural ventilation it is necessary to provide some artificial method of changing the air, and in practice this has been found to be by no means an easy task.

The question of the ventilation of tunnels forms the subject of a series of articles by M. Raymond Godfernaux, published recently in *Le Génie Civil,* these forming a complete monograph treating of the conditions found to exist in practice, together with the theoretical considerations which govern the possible remedies, and in view of the fact that imperfect ventilation has come to be a source of danger as well as discomfort, any discussion which will aid in the solution of the problem is welcome.

The principal sources of definite information, and those upon which the discussion of M. Godfernaux is based, are the reports of the committee on ventilation of tunnels of the Metropolitan Railway of London, and of the commission appointed by the Italian Minister of Public Works to investigate the tunnels of the railways of the department of the Adriatic.

Although the vitiation of the air in a tunnel may proceed from three sources, *i. e.*, the lighting, the respiration of the passengers, and the combustion of the fuel in the engines, yet the two former sources are insignificant compared with the latter, which alone need be considered. The principal products of combustion which are injurious are carbonic acid, carbonic oxide, and sulphurous acid. Of these it is found that the proportion of carbonic oxide should not exceed 0.01 per cent., which corresponds to 0.13 per cent. of carbonic acid in excess of the normal proportion of 0.03 per cent. and to 0.00027 per cent. of sulphurous acid. In practice it is found that if the total proportion of carbonic acid be limited to 0.15 per cent. the proportions of the other gases will be well within the comfort and danger limits. This is much lower than is often attained in crowded auditoriums, where the proportion of carbonic acid sometimes reaches 0.4 to 0.5 per cent., but in such cases there is no carbonic oxide produced, while in the case of tunnels traversed by steam locomotives we may assume that the carbonic oxide will be about 1-13 of the carbonic acid, and the sulphurous acid about 1-440.

Assuming a given limit of deterioration of the air it would be easy to devise a system of ventilation if it were possible to treat the tunnel as if it were a closed room or controllable space. In practice, however, the conditions are peculiar. The space to be ventilated is a long narrow passage, usually open only at the ends, and traversed periodically, often almost continuously, by trains in one or both directions, these trains emitting the objectionable gases and also disturbing the air currents best adapted to proper ventilation. How best to reconcile these conflicting conditions forms the problem under consideration.

Where there are but few trains it has been proposed to close the ends of the tunnel by doors and provide a fan exhaust or pressure system, but this method is obviously limited in its applications. The practical conditions which must be considered are those in which frequent trains in opposite directions pass through the tunnel, and these conditions M. Godfernaux has analysed graphically in a very interesting manner. Assuming a double track tunnel 800 metres in length with an exhausting ventilator placed in the middle, and with trains of a given gas producing capacity passing on each track every three minutes, he constructs a diagram showing how the composition of the atmosphere of the tunnel varies at successive points, and how by an examination of the diagram thus made it is possible to discover the maximum vitiation of the air, and consequently the extent to which the conditions are satisfied. By one or two such constructions any such problem may be solved to a degree quite within the limits of practical work, and the effect of various systems of ventilation compared.

M. Godfernaux discusses various systems of ventilation, including those involving the use of shafts, fan blowers and exhausters, and air jets, and concludes with a description of the Saccardo system, already described in these columns, as applied to the Appennine tunnel of the Bologna-Pistoia line, and to the St. Gotthard tunnel.

While all this investigation and discussion is of much value, it certainly seems as if the true remedy lies not so much in the removal of deleterious gases as in the absence of their production. The substitution of electric traction avoids altogether the fouling of the air of tunnels and subways, and electric locomotives are already used in the Baltimore tunnel in the United States and elsewhere, and it seems as if this remedy is the true one to be applied in all cases.

Alcohol Incandescent Lamps.

THE success which has attended the introduction of the Auer incandescent mantle in connection with lighting by gas has led to various attempts to utilise the same principle with other heating media, especially with petroleum, alcohol, and various combined fluids. This matter formed the subject of a paper before the *Société des*

Ingénieurs Civils de France by M. Denayrouze, who has himself contributed extensively to the improvements which have been made in lighting by incandescence, both in connection with gas and with liquid hydrocarbons.

It is well understood that the illuminating power of gas is entirely due to the incandescence of particles of carbon, and the wastefulness of this mode of lighting may be realised when it is understood, according to Saint-Claire Deville, that the hydrocarbons which form the illuminating portion of ordinary gas constitute but from 3 to 6 per cent. of the total volume, while the remaining portion is capable by its combustion of raising a much large mass to incandescence than is provided by the hydrocarbons present. It is its great richness in readily decomposed hydrocarbons which renders acetylene of such high illuminating power, while the introduction of an incandescent mantle composed of rare earths, as in the Auer burner, shows how great an advance may be made with ordinary gas.

It was a natural step to attempt to place such mantles over burners fed with liquid fuel, and in Germany various designs have been made, using methylated spirit, and even petroleum. Difficulties of various kinds were encountered, however, the principal one being an insufficient admixture of air to produce the high temperature necessary, and most of the devices are still in the experimental stage.

M. Denayrouze exhibited before the Société, however, a lamp containing the results of his latest researches which seems to show that the difficulties have been surmounted in a practical manner.

An ordinary Welsbach mantle can be heated to incandescence over an alcohol burner and thus be made to emit a brilliant light, but the cost is higher than desirable and the illuminating power limited. M. Denayrouze has taken this idea and supplemented it by charging the alcohol with hydrocarbons in solution to such an extent that the carbon in the flame and deposited upon the mantle also becomes incandescent, and adds greatly to the light without causing any increased consumption of alcohol.

While M. Denayrouze exhibited his lamps freely before the society, he did not give any very precise details as to the nature and quantity of the dissolved hydrocarbons which he used to reinforce the illuminating power of the mantle. The idea, however, is readily intelligible and there should be little trouble in reproducing his results, now that the matter has been made public. The effect of the carburetted alcohol is clearly shown by the fact that when burned in specially designed lamps a very brilliant light is produced without the use of any mantle whatever, so that the combination of the two sources of light, especially when assisted by a slight blast of air, gives remarkable results.

The field of investigation which has thus been opened should lead to an active study and to the development of sources of illumination hitherto little used, and while electric lighting and incandescent gas-lighting will probably hold the larger portion of the field between them for a long while to come, yet for portable lighting, such as railway carriages, and similar service, some system such as offered by M. Denayrouze may be found decidedly preferable.

Internal Combustion Motors.

The high economy which has been demonstrated to be possible in the case of the Diesel motor has attracted much attention to internal combustion motors of all sorts during the past year, and there appears to be little doubt that much better results can be attained from various forms of such machines than had hitherto been thought practicable.

Among those who have devoted attention to this subject is the chief engineer of the well-known firm of Ganz & Co., of Budapest, Professor Donat Banki, and a very complete discussion by him of the principles involved in the economic performance of internal combustion motors is given in a recent issue of *Le Génie Civil,* being a translation of the original paper in the Hungarian review *A Magyar Mörnèk.*

Assuming that the phenomena in the cylinder of a motor of the internal combustion type may be considered simply as those bebelonging to the variations in pressure and volume of a given mass of air under varying conditions of temperature, Professor

Banki proceeds to investigate the influence of various modes of introduction of heat in the cycle. This he does, as others have also done, by the study of various curves, constructing what are practically indicator diagrams for the different conditions assumed. By comparison of these curves he then seeks to determine which one, for a given compression may be expected to give the highest degree of efficiency.

By a similar analysis Herr Diesel concluded that the greatest economy would be secured by isothermic combustion, the loss of heat by conversion into work exactly corresponding to the generation of heat by combustion, the temperature during expansion therefore remaining constant, and these conditions he sought to realise in his motor. This method involves a continuous combustion, and not a very rapid, or almost instantaneous explosion, and Diesel has designed his motor so as to feed the combustible gradually into the cylinder, where it is slowly and completely burned.

Professor Banki, however, deduces that the highest economy is attained when the terminal temperature is the lowest, assuming in each case the same quantity of heat, and demonstrates mathematically that this is secured by a motor of the explosion type, the combustion being practically instantaneous.

This conclusion is based upon the same degree of compression in each case, and a further examination is then made into the influence of compression upon economy. Here some interesting deductions appear. The compression may be either isothermic or adiabatic, and Professor Banki shows that the latter should theoretically give the best result. The degree of compression, however, has an important influence. For moderate pressures it appears that the indicated and mechanical efficiency is greater for explosion motors than for combustion motors, while for high degrees of compression the two varieties approach more nearly in efficiency, and for very high compressions the advantage is on the side of the combustion motor.

In the case of high compressions it is necessary to compress the air separately from the fuel, in order to avoid premature ignition, and this is the practical method adopted in the Diesel motor.

The conclusions of Professor Banki might readily be checked by experiment, and in fact such tests as have been made with motors of the types discussed confirm his deductions. For motors operating with slow combustion the compression should be as nearly adiabatic as possible, and there should therefore be as little cooling of the cylinder as possible, only sufficient to prevent injury to the cylinder and piston being employed.

If the combustion can be controlled, the best result should be expected by providing an isobaric combustion, the pressure neither rising nor falling until the fuel is consumed, and this with adiabatic compression will give a high degree of economy if the compression is sufficiently high. If the compression reaches 30 atmospheres the thermal efficiency may reach 40 per cent., a degree not yet attained in actual practice.

Professor Banki is most ready to give Herr Diesel full credit for the work he has done in indicating and applying the correct theoretical principles to internal combustion motors, and considers his work to be as important in petroleum motors as was the introduction of the four-cycle compression gas-engine by Otto in its line.

Professor Banki has himself devised a motor in which high compression may be employed in connection with the simultaneous admission of the combustible without danger of premature ignition, by using a sprayed injection of water into the working cylinder. The presence of the moisture delays the ignition to any desired point, while after, or rather during, the combustion the spray is converted into steam, the motor practically becoming a steam engine using superheated steam generated in the cylinder itself. Several engines of this design have been constructed and show an efficiency equal to that of the Diesel motor, a consumption of only 208 grammes of petroleum per horse-power-hour being required, with a mean effective pressure of 10 atmospheres.

Under these circumstances it appears as if it were only a question of a very brief time before petroleum motors designed upon the principles demonstrated by Diesel, Banki, and others will come into general use, not only for small powers but also for general service.

Incandescent Electric Lamps.

An important question in connection with the operation of electric lighting plants is that of the value and efficiency of various forms of incandescent lamps, and a valuable discussion of the relation between power consumed and illumination furnished forms the subject of a paper by Inspector Loch, in a recent issue of *Glaser's Annalen.*

The ordinary life of an incandescent lamp is placed at 800 to 1,000 hours, but this extreme duration of the filament is by no means the measure of its illuminating usefulness. The real point at issue is the maintenance of uniform illuminating power. In some instances lamps reach a life of 1,000 hours only with a great diminution in brilliancy, while in others a useful life of 3,000 to 4,000 hours has been attained.

As a rule those lamps which yield a brilliant light at first for a given consumption of electrical energy, show also a more rapid falling off in brightness than those which start with a weaker light.

With the failing off in illuminating power there appears also an increase in the consumption of electrical energy. An average consumption for a new lamp is from 2 to 4 watts per Hefner candle, while this may increase to 9 watts per candle before the lamp fails.

There is, however, a great difference in different lamps, even of the same makers. Lamps rated at 16 candles are found to vary between 10 and 30 candles, while 25 candle lamps may range from 15 to 50 candles. A moderate increase in pressure makes a marked increase in brilliancy, and hence Siemens & Halske stipulate for a variation in pressure of not more than 2 per cent. either way from the normal rating of their lamps, *i. e.,* for a 16 candle lamp at 110 volts the pressure should not exceed 112 volts nor fall below 108 volts.

In order to investigate the subject fully, Herr Loch conducted a series of experiments upon a number of incandescent lamps, noting both the life and duration of brilliancy as well as the consumption of electrical energy, the results being plotted in the form of curves. The lamps for the tests were furnished by the makers in accordance with certain specifications, with the intention of securing, as nearly as possible, articles of normal character. Each lamp was required to be tested, and it stipulated that during the first twenty-four hours the illuminating power should not vary more than 6 per cent. either way from the normal, while each lamp was also obliged to stand a run at pressures 2 per cent. above and below the normal rating without showing injury. The normal consumption of energy was required to fall between the limits of 2, 5, and 3.5 watts per candle, and the illuminating power must not fall more than 15 per cent. during the first 480 hours. At the end of this period it was also required that the consumption of electrical energy should not have increased more than 20 per cent. over that required at the beginning.

The records of the tests are given very fully in the article referred to, both graphically and in tabular form, and to the original publication the reader must be referred. The general conclusions, however, were altogether clear, and can readily be summed up.

The tests, as indicated above, were made for twenty-four hours, in order to enable the preliminary measurements to be made, after which the 480-hour trial followed, and such lamps as survived were then continued on trial until a total of 960 hours had been completed.

The general result of the investigation showed that the consumption of electrical energy continued about the same per lamp throughout the entire test, having fallen off but slightly at the termination of 960 hours, but the illuminating power diminished steadily during the same time, so that the power per candle increased materially; in one case the energy per candle increasing from 2.45 watts to 6.75 watts, the candle power having fallen from 24 to 8 during the run of 960 hours.

These evidences of deterioration in incandescent electric lamps correspond to a great extent to those which have been noted in connection with incandescent mantles for gas lamps. A similar falling-off in illuminating power is observed, while the consumption of gas remains the same and hence the efficiency is reduced. It is evidently in the interests of economy to observe the performance of both kinds of lamps and replace them before the waste becomes excessive.

REVIEW OF THE AMERICAN PRESS

The Water Supply of a Great City.

THE tendency of the times to the concentration of population in great centres has brought with it many problems connected with sanitation which demand the best skill of the engineer for their solution, and among these problems one of the most important is that of water supply. The latest contribution to this subject is found in the report of the board of experts appointed to recommend the best means for the extension and improvement of the water supply of the city of Philadelphia, and in view of the high standing of the experts, Messrs. Hering, Wilson and Gray, and of the magnitude of the undertaking, the report has been awaited with interest by that large branch of the engineering profession engaged in municipal work.

For a long time the water supply of Philadelphia has been a subject of very just complaint. In the words of the report: "The water supplied to some parts of the city is scarce in quantity, and in all parts inferior in quality." The supply is drawn from the Schuylkill and Delaware rivers, which although originally pure, have long since become greatly contaminated by drainage and other pollution, so that last summer an epidemic of typhoid fever was produced.

As a natural consequences of these complaints various propositions have been made from time to time looking to the improvement of the water supply, and, as usual in such cases, a number of "schemes" have appeared looking to private profit rather than to public welfare, the political element in these "water snakes" being especially prominent. Most of these schemes involved the bringing of supposedly pure water from a distance, and a number of such sources of supply have been proposed, but on the other hand it has been maintained that the true sources for the city's water supply were the rivers already at hand, it being held perfectly feasible to purify the water so as to render it palatable and wholesome.

The great difficulty attending the introduction of any satisfactory purification process in Philadelphia has been the excessive waste which has been permitted, the water department being obliged to supply nearly 200 gallons per head per day for every man, woman and child of the 1,300,000 population. The present very able Chief of the Water Bureau has called attention year after year in his reports to the fact that this waste must be stopped before any system of purification could be applied, and he has persistently and consistently advocated the introduction of water meters and the construction of filtration plants.

Notwithstanding the fact that a complete and satisfactory solution of the problem had thus been presented, the municipal authorities decided to call in a commission of experts to report upon the "immediate improvement and extension of the water supply," and this commission has been brooding over the subject for more than three months, the result being the report which is now made public.

In many respects this report is very interesting reading, and although much of it relates directly to the conditions belonging to the local situation, yet it contains so much important matter which applies to other large cities that an abstract of its contents is of more than local interest.

After a brief description of the present plant the report takes up the question of waste and shows that it has grown up almost entirely since the introduction of modern sanitary appliances, which in themselves are not wasteful of water, but which readily become so by neglect. In 1885 the consumption was about 75 gallons per head per day, and the condition of the health of the city at that time, as well as the experience gained from other cities, shows that this amount is ample for all reasonable purposes. The commission, however, for some reason known to itself, recommends that the basis of future supply be made double this, or 150 gallons, and then proceeds to advocate the introduction of meters to limit the consumption to this amount.

On the question of meters the report is outspoken and fearless, and it is a matter for congratulation that this important measure has received such an unqualified indorsement. The report says:

"We earnestly recommend the introduction of meters for the city of Philadelphia with perfect confidence that the private consumer is given full and ample use and enjoyment of all water for his needs and comforts, at no greater cost, and probably, in many cases even less cost than the present rates impose."

Assuming then that the supply be reduced to limits which the most rabid advocates of liberality must admit are more than ample, the commission goes on to recommend sand-filtration as entirely capable of rendering the water of the Schuylkill and Delaware rivers pure and wholesome.

Many people have an idea that filtration is nothing more than a sort of straining, rendering the water clearer than before, but not removing the sources of disease which may be contained in the form of pathogenic bacteria. The report shows, as indeed is well known to those who have studied the subject intelligently, that from 98 to 99 per cent. of the bacteria are removed entirely by filtration and that "a filtered water supply, under skilful management, offers a greater security against the effects of accidental pollution of the water than is possible when the supply is taken from open, unprotected water courses. Filtration can without difficulty be made to render the water thoroughly wholesome."

Here, then, are enunciated the two fundamental principles of water supply for any great city situated by a river. First, the use of meters, to prevent the waste from becoming so great as to render filtration impracticable; and, secondly, the use of slow sand filtration, a process covered by no patents, but open to all, as a means of providing, even from polluted sources, a supply entirely wholesome and satisfactory.

It is especially interesting to note that these conclusions are identical with those which the present Chief of the Philadelphia Bureau of Water, Mr. John C. Trautwine, Jr., has been urging upon the city authorities for a number of years, and in fact the report of the commission reads as if it had been compiled entirely from Mr. Trautwine's annual reports to the Director of the Department of Public Works. The city might well have been spared the delay and expense of this special commission, simply by following the recommendations of its own expert engineer, but having acted otherwise, it is at least assured that these important recommendations will be well carried out by the man with whom they actually originated.

Mechanical Stokers on Shipboard.

It is generally admitted that the stoking of marine boilers ranks among the most laborious and exhausting occupations, and in view of this fact as well as of the important influence which careful stoking has upon the economic performance of the boilers, it is somewhat surprising that greater efforts have not been made to apply mechanical stokers to marine boilers.

An important contribution to this branch of work now appears in the *Journal* of the American Society of Naval Engineers in the form of an account of the test of the machinery of the lake steamship Pennsylvania, by Lieutenants B. C. Bryan and W. W. White, U. S. N., this test including not only the stokers, but also the main engines, auxiliary machinery, and water-tube boilers. Although the vessel is the property of a private company, the test was made under the auspices of the Bureau of Steam Engineering of the United States Navy Department, and thus the results may be considered as official.

The Pennsylvania is a large steamer, being 450 feet in length over all, with a displacement of 10,155 tons, and is fitted with a quadruple expansion engine of 1,600 h.p., two Babcock & Wilcox water-tube boilers, intended for a pressure of 250 pounds, with three mechanical underfeed stokers to each boiler, and an entire equipment of independent steam auxiliaries, none of the auxiliary machinery being operated by the main engines.

Although full data of the tests of all this machinery are given in the paper, it is distinctly stated that they were primarily made for the purpose of observing the practical adaptability of underfed stokers, as manufactured and installed by the American Stoker Company, to boilers of sea-going vessels, especially with a view of determining the economic results where an inferior grade of slack coal is used. The coal used on the Pennsylvania contained a large proportion of refuse, and a sample tested in a Mahler bomb calorimeter gave a calorific value of only 11,790 B. T. U. per pound.

The stoker consists essentially of a central magazine, a coal hopper, a screw conveyor or worm, a wind box, cast-iron tuyeres or air blocks, and an independent steam motor for driving the conveyor shaft. The coal which is thrown into the hopper is fed into the central magazine of the stoker and forced upward, gradually overflowing the tuyere blocks. The volatile gases are gradually released by a sort of coking, and burned in connection with air issuing through the tuyere blocks, and the coked fuel finally burned on the dead grates at the sides.

Five full tests of six hours' duration were made of the main engine, including, of course, the boilers and stokers. During these tests all the water fed to the boilers was weighed in tanks, the coal also being carefully weighed on platform scales. The steam used by the auxiliaries was determined by condensing the exhaust and weighing the water, while the quality of the steam made by the boilers was determined by the Barrus calorimeter. Indicator cards were taken at frequent intervals, and the flue gases from the furnaces were tested by the Orsat apparatus.

In the original report full tabulated records of the data and results of the tests will be found, and there is only space here for a statement of the general results.

The only numerical statement which can be obtained of the performance of the stokers is that of the evaporative performance of the boilers, and when it is seen that the evaporation was 8.8 pounds of water per pound of slack, or 10.9 pounds per pound of combustible, with practically dry steam, it will be seen that the firing must at least have been as good as hand firing. According to the text of the report it is stated that: "The steam was generated at all times without difficulty, and no doubt with greater ease and economy than if hand firing had been employed. Only an extremely light smoke was observable during the ordinary working of the stokers. Practically it may be said the coal was burned smokelessly, except when the cleaning doors were opened, either for slicing or clinkering. At such intervals considerable smoke issued from the stack."

These trials then appear to have demonstrated that under the conditions existing upon freight steamers on the great lakes, mechanical stoking is both feasible and economical. It must be remembered that these trials were made with water-tube boilers, but there appears to be no good reason why such stokers cannot be used to advantage with cylindrical boilers, although there is every probability that the water-tube boiler will soon become the rule for marine service. The substitution of machinery for human labor in this exhausting work is certainly greatly to be desired, both for mechanical and sociological reasons.

The tests of the machinery showed, among other things, two interesting facts, one being that the quadruple expansion engine gave little or no gain in economy over triple expansion engines as now designed for pressures approaching 250 pounds, and the other, the fact that when the exhaust steam is used for heating the feed water, steam auxiliaries may be operated at a cost of only about 10.5 per cent. of the total steam generated by the boilers. "The cost, therefore, of operating independent auxiliaries in connection with an exhaust feed-water heater, as compared with attaching them to the main engine, when the above percentage is not exceeded, is only trifling, and more than offset by the many obvious advantages of independent machines."

Reaction Breakwaters.

THE use of parallel jetties for the purpose of concentrating the scouring action of streams is well known, and when applied with judgment this method of deepening channels has proved eminently successful, a notable example being the work of the late Captain James B. Eads at the mouth of the Mississippi river. In many cases, however, it is desired to deepen the channel over a bar where there is no river discharge to be concentrated, and in such cases the contraction of the harbor entrance by means of jetties has not always proved successful.

A number of years ago Professor Lewis M. Haupt, of Philadelphia, brought forward a method of improving tidal harbors by means of the so-called reaction breakwater. This idea consisted in the application of a curved breakwater, so arranged that the potential energy of the ebb current was concentrated on the crest of the bar, producing the scour needed to deepen the channel.

Although Professor Haupt's idea did not at first meet with approval by Government engineers, yet, after other plans had entirely failed, his system was allowed to be tried at Aransas Pass, Texas, and the nature and result of the experiment is discussed in a paper presented before the American Society of Civil Engineers, and published in the *Proceedings* of the society.

The difficulty of the situation at Aransas Pass renders the problem one of especial interest. There is no stream to be directed or utilized, and the tide is but slight, being only 14 inches, so that the available energy is not great. Attempts were made by the government to build a jetty and to produce a 12 foot channel, but after the expenditure of more than half a million dollars this attempt was abandoned.

In 1895, a private company undertook the construction of a reaction breakwater after Professor Haupt's method. This breakwater is of an S shape, being detached from the shore in order to permit the tidal compartments of the inner bays to be filled freely by each flood tide. The breakwater is composed of curves whose radii and centres are adjusted to the site in such a manner as to cause deposits on the outer side of the structure, thus re-enforcing it, and scour on the inner side where an excess of foundation material revets the slope, the scour being assisted by gravity and the advance of the bar seaward thus prevented.

In the construction of this work a portion of the old jetty was encountered, and the intersection of the two works formed a sort of pocket which caused an accumulation of sand and prevented scour. A partial breach in the old jetty was made although it was not entirely removed, neither was the reaction breakwater entirely completed. The work was left in this condition early in 1897, and at that time a depth of but 8.5 feet was reported. The Government engineers evidently considered the breakwater a failure, and so reported, but now it appears that during a period of 15 months the artificial scour produced by the breakwater has increased the depth to more than 22 feet. This remarkable result tends to confirm the theoretical views of Professor Haupt, and to show that the force of even a moderate tide, when properly directed, may be utilized to produce a navigable channel, unaided by the flow of a stream or by dredging.

This simple structure marks a distinct advance in the resources of maritime engineers in the improvement of ocean bars, and its success in this instance should lead to its extensive adoption. Those who realize the efforts which Professor Haupt has made to convince the engineering world of the soundness of his views in this matter cannot fail to be gratified at the success which has attended this practical demonstration of the correctness of the principles which he has advocated.

Concrete-Steel Bridge Construction.

THE readers of these columns must have observed the frequency with which articles upon the subject of reinforced concrete have been reviewed, and it is believed that this fact is but an indication of the general interest which is taken in the subject. Most of the published accounts of structures of this character have appeared in continental publications, but of late a number of combined steel and concrete bridges have been built in the United States, and now we have in a recent issue of *Engineering News* a very full discussion of the whole subject, by Mr. Edwin Thacher, who is well qualified by experience to speak with authority.

As defined by Mr. Thacher: "A concrete-steel structure is a combination of concrete and steel in which steel in any form is rigidly embedded in concrete, the concrete stiffening the steel, and the steel reinforcing the concrete."

Such combinations are possible for the reason that concrete and steel have practically the same coefficient of expansion, so that the two elements of the structure act together in resisting the stresses.

Originally the idea of reinforcing concrete structures by iron or steel was suggested by the greater resistance of concrete to compression than to tension, and

Monier, in whose efforts the present extended interest in the matter originated, began simply by imbedding wire nettings in concrete arches, placing the metal near the surface of the intrados and extrados, in order to meet the tension stresses which might be developed in those portions of the structure. The results were so remarkable that general attention was directed to this form of construction, and as the use of nettings was attended with structural inconveniences, Professor Melan suggested the construction of a light framework of steel beams, forming a sort of skeleton structure, the beams being either solid or lattice according to the dimensions, and the whole being buried in a monolithic mass of concrete.

Experience having shown the high resisting power of steel wires to forces tending to withdraw them, when imbedded in concrete, some very simple forms of reinforced concrete construction have been used for short spans, especially in connection with floors and other interior work in fire-resisting building construction. The Hennebique system, composed of concrete beams and floors with imbedded rods, is especially interesting as an example of girder construction without the use of arches, while the applications of expanded metal as a strengthening adjunct to concrete walls, partitions, etc., are numerous and successful.

Assuming, as practice warrants, that the concrete and steel act as one mass, it is necessary to consider the elasticity of both materials in computing the proportions of such structures, and Mr. Thacher shows in his paper that graphical methods lend themselves especially to these computations, and that the thrusts, bending moments, and shears are quickly and accurately found graphically, after which the application of a few simple equations, given in the article, enable the proper distribution of materials to be made.

Much of the present confidence in reinforced concrete has been the result of the exhaustive and valuable tests made by the Austrian Society of Engineers and Architects, and Mr. Thacher quotes freely from the report of the commission having those tests in charge. A list of important arches which have been constructed in various countries is also given and an especially valuable collection of data concerning materials and workmanship.

The question as to the durability of iron or steel when imbedded in concrete seems to be fairly well settled, and examples of structures which have been demolished after many years show that the concrete acts as a preservative and that little or no rust takes place.

Mr. Thacher quotes the saying of Mr. George S. Morison, that he "believes that we are now only at the beginning of concrete construction, and that if the results we hope for can be obtained with concrete structure with metal inside, the time will come when this will be the one method of building."

The Cost of Electricity in Buildings.

It is generally assumed that electricity can be supplied to buildings more cheaply than it can be generated by isolated plants, but that this is not always the case is shown in a carefully prepared paper read before the American Institute of Electrical Engineers by Mr. Percival R. Moses.

Mr. Moses has collected information from more than a hundred buildings of various sizes and types, and from these he has selected those from which the information was furnished with such a degree of detail as to render the conclusions reliable. The buildings selected include hotels, office buildings, loft buildings, department stores, and apartment houses, all in the city of New York, and since liberal access to the books of the establishments was permitted the data are of much interest.

In the investigation of the buildings the hourly variations in the demand for light and power were plotted in the form of curves, and in each case a proportional allowance made for depreciation, interest, and other fixed charges. A typical building was taken in each case, and as these cases include actual records of the cost of supplying the same buildings, under the same conditions, with electricity, both from their own isolated plants and by the central station, it certainly appears as if the comparisons have been made upon a fair basis.

In considering the isolated plant it must be remembered that in nearly, if not all, such buildings a steam power plant must be maintained in any case, or at least steam must be used for heating, and if the steam power does not provide sufficient exhaust steam to warm the building live steam must be used. The installation of an isolated electrical plant is therefore only a partial increase in operating expense, in such cases, and not so great as it would be if the entire power plant had to be placed solely for the operation of the electric machinery.

We give here only the conclusions which Mr. Moses draws from each building considered by him, and the full data in each case will be found in his original paper. Taking a table which Mr. Moses has prepared for buildings using approximately from 825,000 kilowatt-hours per annum down to 40,000 kilowatt-hours, he shows that the costs per kilowatt-hour for isolated plants are as follows:

Large Hotel	1.66 cents.
Small Hotel	2.45 "
Apartments	4.70 "
Department Store	2.85 "
Small Store	4.10 "
Large Office Building	4.37 "
Small Office Building	5.06 "
Loft Building	2.60 "

When it is understood that the charges by the central station company, taken from the published reports, are, on an average, 10.6 cents per kilowatt-hour, and that the cost of production is about half this, it appears that under existing conditions in New York the private consumer can generate electricity at about the same cost, or even less cost than the central company, and that there is a manifest economy in the installation of the isolated electric plant.

Comparative Cost of Mechanical Traction.

It is not often that such an excellent opportunity is offered for the comparison of costs of various forms of tramway traction as is given at the present time, since the Metropolitan Street Railway Company, operating electric, cable, and horse traction tramways in New York City, has given for publication in the *Street Railway Journal* a comparative exhibit of the receipts and expenses in detail of its various lines, similar to that which was published for the same lines one year ago. Since the track mileage is the same as it was a year ago a close comparison can be made of the growth in the system during the year, and the influence of this growth on receipts and expenses may to a great extent be observed.

"Taken as a whole, the Metropolitan system was operated last year at 15.18 cents per car mile, as against 15.83 cents in the previous year, and the earnings from operation have become 15.50 cents, as against 13.87 cents in 1898. The electric lines have made all of this increased earning power, and have, in addition, overcome a combined diminution on the horse and cable lines of 1.15 cents per car mile."

That the public responds promptly to increased facilities is shown in the fact that during the last year the company ran its cars over the same trackage nearly 42,000,000 miles, as against but 35,000,000 miles in the previous year, the new cars being also nearly double the capacity of the old ones. This resulted in an increase of nearly 25 per cent. in the passenger receipts, and an increase of about 3 per cent. in the receipts per car mile.

The percentages of operating expenses to passenger receipts of the three motive powers compare as follows:

	1898.	1899.
Cable	47.8	50.8 per cent.
Electric	37.9	38.3 " "
Horse	65.3	69.8 " "
Total	53.3	49.4 " "

These figures give a fairly correct idea of the relative commercial value of the several methods of traction operated under nearly similar conditions, but some comments may be added in explanation.

The cost of electric motive power proper, excluding certain charges for horse connections upon some short lines operated with the electric lines, was 1.21 cents per car mile in 1898, and 1.57 cents in 1899, but it must be remembered that many of the cars operated in the latter year were much larger and heavier than the old cars. The new 70,000 h.p. station was not in operation at all during the year, and the advantage of economical power was therefore not yet obtained, and the temporary power stations, operated in connection with storage batteries are by no means adapted to handle the great loads economically, being taxed severely during certain hours of the day.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w*. Boston, U. S. A.
American Electrician. *m*. New York.
Am. Engineer and Railroad Journal. *m*. New York.
American Gas Light Journal. *w*. New York.
American Geologist. *m*. Minneapolis, U. S. A.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Am. Manufacturer and Iron World. *w*. Pittsburg, U. S. A.
American Shipbuilder. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Architect. *w*. London.
Architectural Record. *q*. New York.
Architectural Review. *s-q*. Boston, U. S. A.
Architecture and Building. *w*. New York.
Australian Mining Standard. *w*. Sydney.
Automotor & Horseless Vehicle Jl. *m*. London.
Brick Builder. *m* Boston, U. S. A.
Bridges. *m*. Chicago.
British Architect. *w*. London.
Builder. *w*. London.
Bulletin Am. Iron and Steel Asso. *w*. Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m*. Brussels.
California Architect. *m*. San Francisco, U. S. A.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Montreal.

Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Accident.

A Lesson from a Building Accident. Describes the partial collapse of a building through the failure of a brick pier. Ill. 1000 w. Br Build—Sept., 1899. No. 29799 C.

Cow Sheds.

Construction of Cow Sheds. Sidney Villar. Extract. On the sanitary arrangements to secure freedom from tuberculosis and health of the animals. Suggestions for floors, ventilation, drains, etc. 2600 w. Arch, Lond—Sept. 8, 1899. 29678 A.

Dewev Arch.

The Dewey Arch. Illustrated description of the arch being built by the National Sculpture Society. 1200 w. Sci Am—Sept. 16, 1899. No. 29610.

Exposition.

A Visit to the Works of the Exposition of 1900 (Visite aux Chantiers de l'Exposition Universelle de 1900). Max de Nansouty. An account of the visit to various portions of the Exposition grounds by a party of members of the Society of Civil Engineers of France. 5000 w. Mem Soc Ing Civ de France—June, 1899. No. 29845 G.

The Austrian Government Building at the Paris Exposition (Das Oesterreichische Repräsentationshaus in der Weltausstellung, Paris, 1900). A description of the building, with plates showing the external and internal construction. 1200 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1899. No. 29817 D.

The Palaces on the Champs-Elysées (Les Palais des Champs-Elysées). E. Rouyer. Describing the progress of the construction of the large and small palaces of fine arts for the Paris Exposition. 2 articles. 6000 w. 2 plates. Génie Civil—Sept. 2, 9, 1899. No. 29825 each D.

Ice House.

Model Ice Storage House. Outlines and illustrates the plans and specifications of an ice-storage house at El Reno, Okla. 1500 w. Ice & Refrig—Sept., 1899. No. 29447 C.

Lighting.

The Luxfer Prisms (Les Prismes Luxfer). P. Grandjean. An examination of the theory of the use of prisms for improving the lighting of rooms, with examples showing the practical application. 8000 w. Rev Univ des Mines—Aug., 1899. No. 29841 G.

Pantheon.

The Paradox of the Pantheon. A. D. F. Hamlin. A study of ancient Roman vault construction, giving the writer's theory and the reasons that led him to adopt it. Ill. 2000 w. Sch of Mines Quar—July, 1899. Serial. 1st part. No. 29520 D.

Roof.

The Failure of the Chicago "Coliseum" Roof Arches. A statement of facts in regard to the cause of the fall of the twelve steel arches forming the main roof. Ill. 2500 w. Eng News—Sept. 14, 1899. No. 29617.

Roofing.

Felt and Gravel Roofing. Calls attention to some of the weak points and the way of avoiding them. Ill. 700 w. Met Work—Sept. 16, 1899. No. 29629.

Sand-Blast.

The Sand-Blast in Architectural Work. B. F. Fells. Illustrates and describes how to build and use a sand blast, and sand-sifting apparatus. 900 w. Am Arch—Sept. 9, 1899. No. 29537.

Theatre.

Recent Theatre Construction. Illustrated description of the metal work in a Jersey City theatre. 1500 w. Eng Rec—Sept. 16, 1899. No. 29654.

Vaults.

Vaults without Centerings. From *La Nature*. Illustrations and notes concerning the modern method employed for the construction of vaults. 1200 w. Sci Am Sup—Sept. 9, 1899. No. 29510.

HEATING AND VENTILATION.

Centrifugal Fans.

Centrifugal Ventilators. J. T. Beard. A review of designing practice, past and present, showing where the study of design should begin, the need of formulas correlating all the elements of the ventilator and the work, etc. Ill. 2800 w. Mines & Min—Sept., 1899. Serial. 1st part. No. 29459 C.

Hospital Ventilation.

Hospital Planning in Regard to Plenum Ventilation. William Henman. Read at the San. Inst. Congress. Describes the arrangements made for ventilating the Belfast Royal Victoria Hospital, and the advantages of the Plenum system. 1800 w. Brit Arch—Sept. 15, 1899. No. 29769 A.

Hot-Water.

An Exhaust Hot-Water Heating Plant. Illustrated description of the heating plant of a school building on Staten Island. 1500 w. Eng Rec—Sept. 23, 1899. No. 29904.

Tunnels.

See Railway Affairs, Permanent Way.

Vacuum System.

The Vacuum System of Heating. D. F. Morgan. On the advantages of this system, and the use of the vacuum producing air valve. 1900 w. Met Work—Sept. 16, 1899. No. 29628.

PLUMBING AND GAS FITTING.

Drainage.

House Drainage. Abstract of a paper by Lamorock Flower, on "The Drainage of Buildings Possessing No Open Space," read at the Congress of the Sanitary Institute, England. 800 w. Arch, Lond—Sept. 8, 1899. No. 29679 A.

Registration.

Registration of Plumbers Under the New York Building Law. Extract dealing with the registration of master plumbers. 1000 w. Eng Rec—Sept. 23, 1899. No. 29905.

Regulations.

Plumbing Regulations for Small Cities. Gives the ordinance of Quincy, Mass., a town of twenty thousand people. 1800 w. Dom Engng—Sept., 1899. No. 29753 C.

Water Supply.

Water Supply in a Large New York Residence. Illustrated description of a number of special features for the hot and cold water plumbing. 1300 w. Eng Rec—Sept. 16, 1899. No. 29656.

MISCELLANY.

Building Code.

Structural Regulations of the New York Building Law. Extracts from the new law modifying the previous requirements concerning the quality of materials, foundation, fire-proofing, iron and steel construction, floor loads, and the calculation of the strength of materials. 5800 w. Eng Rec—Sept. 16, 1899. No. 29657.

The Proposed New Building Code for New York City. Extracts from the sections which are of most interest to engineers, with other information bearing on the ordinance. 5500 w. Eng News—Sept. 14, 1899. No. 29622.

Mechanical Plant.

The Mechanical Plant of the Exchange Court Building, New York. Illustrated detailed description of the plant for heating, lighting and power purposes in a twelve-story office building. 2500 w. Eng Rec—Sept. 9, 1899. No. 29641.

CIVIL ENGINEERING

BRIDGES.

Aexander III.

The Alexander Bridge at Paris (Die Alexander-Brücke in Paris). Carl Bernhard. A very full account of the construction of the bridge, with many illustrations of details and erection. 6000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29804 D.

Atbara.

The Atbara Bridge (Die Atbara-Brücke). Inspector Frahm. An account of the circumstances attending the placing of the order for the Atbara bridge, together with a detailed description of the structure and its erection. Two articles, 4000 w. Stahl und Eisen—Aug. 1, Sept. 1, 1899. No. 29829 each D.

Centring.

Iron Centring Used in Constructing the Wienfluss Boulevard. Illustrates and describes the centring used in Vienna for covering the river Wien. 900 w. Engng—Sept. 15, 1899. No. 29791 A.

Concrete-Steel.

Concrete Steel Bridge Construction. Edwin Thacher. Considers in detail the construction of concrete steel arches and other structures, the materials, workmanship, etc., giving specifications for concrete steel bridges. Ill. 11700 w. Eng News—Sept. 21, 1899. No. 29747.

Erection.

American Bridge Erection. Brief illustrated description of the erection of a cantilever bridge over the St. John river, New Brunswick. 400 w. Engr, Lond—Sept. 15, 1899. No. 20784 A.

A Novel Method of Bridge Erection; Connecticut River Bridge, Northfield, Mass. Illustrated description of a curious method of erection without false works which was recently adopted in constructing a highway bridge. 1700 w. Eng News—Sept. 7, 1899. No. 29550.

The Northfield Bridge. Illustrated description of a cantilever structure with a main span of 360 ft., which was erected by a unique method which is explained. 4000 w. Eng Rec—Sept. 2, 1899. No. 29465.

Floating Bridge.

A Floating Bridge in the Philippines. B. F. Cheatham. A letter giving a short description of a bridge constructed by the American army. Ill. 300 w. Eng News—Sept. 14, 1899. No. 29620.

High-Level Arch.

The Müngsten High-Level Arch Bridge. Illustrated description of interesting features. The floor of the bridge is about 354 feet above the surface of the river Wupper, which flows beneath. 1300 w. Sci Am—Sept. 9, 1899. No. 29508.

History.

The Bridge as a Religious Edifice. Extracts from records of the fourteenth to sixteenth centuries concerning a bridge in Barnstaple, England. 1200 w. Eng Rec—Sept. 16, 1899. No. 29650.

Lift Bridges.

New Scherzer Lift Bridges Over the Chicago River. Illustrates and describes the two new rolling lift bridges now building. 500 w. R R Gaz—Sept. 22, 1899. No. 29745.

Scherzer Rolling Lift Bridges Over the Chicago River. States the conditions on this river and gives illustrations of bridges to be constructed. 1200 w. Eng Rec—Sept. 23, 1899. No. 29902.

The Scherzer Rolling Lift Bridge Over the Fort Point Channel, Boston. Describes some of the details peculiar to this particular bridge, giving illustrations. 1500 w. R R Gaz—Sept. 8, 1899. No. 29566.

Rhine.

The New Bridge over the Rhine at Bonn (Die Neue Rheinbrücke bei Bonn). J. L. Algermissen. A very complete general description, with views of the completed structure, and sheets of details. 4500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1899. No. 29818 D.

Tyne Bridge.

Proposed Bridge Over the Tyne. Illustrates and describes a cantilever type with span of 500 ft. in length. 1000 w. Engr, Lond—Sept. 15, 1899. No. 29786 A.

Viaducts.

Reconstruction of Railway Viaducts in Cornwall. Relates to the replacement or reconstruction of the many viaducts on the Great Western main line in Cornwall, without interruption of traffic. 1200 w. Builder—Aug. 26, 1899. No. 29454 A.

MATERIALS.

Asphalt.

An Albertite-like Asphalt in the Choctaw Nation, Indian Territory. Joseph A. Taff. History of the development and report of the material, and the associated rocks. 2000 w. Am Jour of Sci—Sept., 1899. No. 29420 D.

The Laboratory Production of Asphalts from Animal and Vegetable Materials. William C. Day. Describes experimental work, giving a statement of the results obtained, and discusses the origin of natural asphalts. 5500 w. Jour Fr Inst—Sept., 1899. No. 29486 D.

Buckling.

A New Formula for Buckling (Eine Neue Knickformel). F. von Emperger. A comparison of curves deduced from a number of existing formulas with the new formula of Ostenfeld. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 1, 1899. No. 29816 B.

Columns.

Calculation of Cast-Iron Columns. J. B. Nau. Gives diagrams for the rapid and correct calculation of cast-iron columns, explaining their use. 600 w. Eng News—Aug. 31, 1899. No. 29409.

Concrete.

On the Theory of Concrete. Discussion of paper by George W. Rafter. 3800 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29915 E.

CONSTRUCTION.

Breakwaters.

The Reaction Breakwater as Applied to the Improvement of Ocean Bars. Lewis M. Haupt. Gives results of the curved breakwater at Aransas Pass, Texas, and the cause of the effective work; also considers the cost. The theory is explained. Ill. 5800 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29909 E.

Groined Arch.

The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume. Discussion of paper by Leonard W. Metcalf. 600 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29913 E.

Pile Driving.

Pile-Driving Formulas: Their Construction and Factors of Safety. Discussion of paper by Charles H. Haswell. 4200 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29912 E.

Pile Driving Formulas. Discussion of the reasonings and citations given in a paper by Charles H. Haswell in the Pro. of the Am. Soc. of Civ. Engs. 2800 w. R R Gaz—Sept. 1, 1899. No. 29405.

Tunnel.

The First Subaqueous Tunnel in Germany. Brief account of the tunnel in course of construction under the river Spree in Berlin. 900 w. Engr, Lond—Sept. 1, 1899. No. 29590 A.

HYDRAULIC AND MARINE.

Canal.

A Canal from Marseilles to the Rhone. Gives the general features of a new scheme to aid the trade of Marseilles, with critical remarks concerning it. 1600 w. Engr, Lond—Sept. 8, 1899. No. 29696 A.

The Dortmund-Ems Canal. An account of a waterway built at a cost of $18,000,000. 1200 w. Eng Rec—Sept. 23, 1899. No. 29900.

The Emperor at the Dortmund-Ems Canal and at the Union Works (Der Kaiser am Dortmund-Ems Kanal und auf der "Union"). With maps and profiles of the canal, and views of the canal lift and in the Union Works. 2500 w. Stahl und Eisen—Sept. 1, 1899. No. 29832 D.

The Report of the Nicaragua Canal Commission. A full abstract of the report made to the President of the Walker Commission, as published in the *N. Y. Journal* for Sept. 10. 11200 w. Eng News—Sept. 21, 1899. No. 29750.

Dam.

East Canyon Creek Dam, Utah. M. S. Parker. Illustrated description of a rock-fill dam with a steel core in asphalt concrete. 2000 w. Eng Rec—Sept. 2, 1899. No. 29466.

The Chittenden Drum Dam. Illustrated description of a movable dam on the Osage River. 1500 w. Eng Rec—Sept. 16, 1899. No. 29648.

Dredge.

Marine Bucket-Dredge of 1000 Horse Power (Drague Marine à Godets de 1000 Chevaux). An illustrated description of the powerful dredge built for the Russian Government by Smulders, of Rotterdam, for use in the harbor of Vladivostock. 1000 w. 1 plate. Génie Civil—Aug. 19, 1899. No. 29820 D.

Driven Wells.

Sinking Driven Wells. A description of various methods employed in driving wells through earth and rock. 2300 w. Eng Rec—Sept. 16, 1899. No. 29653.

Dry Docks.

See Marine Engineering.

Filtration.

Clear Water from the Mississippi. Illustrated description of the system at Davenport, Ia., by means of which the water is rendered clear and potable. 900 w. Fire & Water—Sept. 9, 1899. No. 29541.

Test of a Mechanical Filter. Edmund B. Weston. Illustrates and describes the results of a three-months' test of filter recently installed for the East Providence, R. I., Water Company. 3000 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29910 E.

Floods.

Predicting Floods in Rivers. A review of the method employed by the government hydraulic engineer of Queensland in foretelling floods on the Brisbane River. 1800 w. Eng Rec—Sept. 16, 1899. No. 29655.

Harbor.

Proposed New Docks and Collieries at Seaham Harbor. An account of the proposed works and favorable prospects of this port. 1100 w. Col Guard—Sept. 1, 1899. No. 29583 A.

Hydrography.

Hydrographic Observations and Measurements in Würtemberg (Die Hydrologischen Beobachtungen und Messungen in Württemberg). H. Gugenhan. An account of the surveys and river measurements made in Würtemberg for a number of years past, with interesting data as to methods of observing and recording. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29807 D.

Irrigation.

Some Irrigation Appliances in the San Bernardino Valley, Cal. Notes from a publication of the U. S. Div. of Hydrography relating to the measurement of streams. Describes a floating weir, a measuring box, stop for diversion, and other appliances. Ill. 1300 w. Eng News—Sept. 7, 1899. No. 29552.

Lift Gates.

Twin Gates for the Fay Lake Reservoir, Arizona. Brief illustrated description of a vertical lift reservoir outlet gate of simple design, presenting some novel features. 250 w. Eng News—Sept. 7, 1899. No. 29558.

Reservoirs.

Flood-Water Channel, Altoona Reservoir. Illustrates main features of an unusual engineering work built to protect the basin from becoming clogged. 1200 w. Eng Rec—Sept. 23, 1899. No. 29903.

River Improvement.

The Improvement of the Big Sandy River. Illustrates and describes the type of movable dam used in the improvement of this river in West Virginia and Kentucky. 6000 w. Eng Rec—Sept. 9, 1899. No. 29638.

Run-Off.

The Volume and Velocity of Run-Off Water (Abfluss-Geschwindigkeit und Quantität). Rudolf Müller. An exposition of a new method of computing the run-off of rain water, with diagrams showing a graphical solution of given cases. 6000 w. Oesterr Monatschr f d Baudienst—Sept., 1899. No. 29819 D.

Surface Drainage.

The Drainage Problem of New Orleans. A statement of the unusual topographical conditions making surface drainage more difficult than sewerage. 1200 w. Eng Rec—Sept. 16, 1899. No. 29652.

Valves.

Outlet Valves at the Burrator Reservoir of the Plymouth Water Works. Edward Sandeman. Gives a general idea of the works and describes the manner in which the outlet pipes are controlled. Ill. 1300 w. Inst of Mech Engs—1899. No. 29723 D.

Water Supply.

Additional Water Supply Works for Dresden, Germany. Abstracted from a paper by Chief Engineer Vacherot before the Dresden Bezirksverein and published in *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrates and describes a pumping plant drawing water from infiltration wells, sunk along the banks of the river Elbe. 800 w. Eng News—Sept. 7, 1899. No. 29557.

A Remarkable Water Supply. Describes ridiculous works furnishing alleged filtered water to Aldeburgh-on-Sea, England. 600 w. Eng Rec—Sept. 16, 1899. No. 29646.

Auxiliary Water Supplies. Describes works for supplying water for other than domestic purposes in Bournemouth, Great Yarmouth, Calcutta, and Richmond. 1200 w. Eng Rec—Sept. 2, 1899. No. 29467.

New Tunnels, Intake Crib, and Pumping Stations, Chicago, Ill. Illustrated detailed description of extensive and important additions to the water supply system of this city. 4500 w. Eng News—Aug. 31, 1899. No. 29411.

New York Water Supply. Discusses the Ramapo water supply project. 3800 w. Engr, Lond—Sept. 15, 1899. No. 29782 A.

The London Water Supply: Its Future. Particulars of the possibilities of the Thames and its tributaries being able to meet the increasing demand. 1000 w. Engr, Lond—Aug. 25, 1899. No. 29435 A.

Water-Waste.

Water-Waste in the Olden Time. Editorial discussion of a criticism in a Boston journal in regard to the construction of the Roman aqueducts being better than the work of to-day. Gives facts showing the conditions were much worse in Rome than in any modern city. 1000 w. Eng Rec—Sept. 9, 1899. No. 29637.

Water-Works.

Private *versus* Municipal Ownership. C. W. Tooke. A review of the Danville, Ill., water case. 2500 w. Munic Engng—Sept., 1899. No. 29484 C.

Syracuse Water Works. W. R. Hill. General description with illustrations. 2700 w. Fire & Water—Sept. 9, 1899. No. 24542.

The Water-Works of Laodicea, Asia Minor. Edward Wegmann. Illustrated description of aqueduct and inverted siphon of stone blocks 7,000 meters long. 1200 w. Eng Rec—Sept. 16, 1899. No. 29647.

Three Engineering Reports on the Ramapo Project. Review of the main features of reports by G. S. Rice, E. E. McLean, and J. J. R. Croes on the proposal to sell New York 200,000,000 gals. per day at $70 per million gals. Mr. Croes gives important figures concerning leakage from old street mains. 2600 w. Eng Rec—Sept. 2, 1899. No. 29471.

Wave Pressures.

The Effect of Waves on Breakwaters. Extracts from a paper by William Shedd, read before the British Inst. of Civ. Engs. A description of the movement of concrete and rubble by wave action on a number of breakwaters. 1400 w. Eng Rec—Sept. 16, 1899. No. 29649.

MEASUREMENT.

Graphical Statics.

Graphic Methods of Determining the Pressure of Earth on Retaining Walls. P. R. Kirk. Considers pressure of earth against a retaining wall with a vertical surface, and pressure on a retaining wall when the surface of the earth is horizontal and level with the top of the wall. Ill. 2800 w. Builder—Sept. 9, 1899. No. 29680 A.

Planimeter.

A Simple Theory of the Polar Planimeter (Einfache Theorie des Polarplanimeters). Prof. Robert Land. A geometrical study of the planimeter, demonstrating the principle upon which its action depends. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29805 D.

Vienna.

The Plan of Vienna at the Time of the Second Turkish Siege (Der Plan von Wien zur Zeit der Zweiten Türkenbelagerung). S. Wellisch. A description of old surveys made before the siege of Vienna in 1683, comparing them with the Hirschvogel map of 1529, and with modern maps. 3000 w. Zeitschr d Oesterr Ingn Arch Ver—Aug. 11, 1899. No. 29811 B.

MUNICIPAL.

Asphalt.

Railway Asphalt Plant. An illustrated description of a portable plant for the preparation of asphalt used in paving, so that this industry may be extended to small cities and towns. 1800 w. Ry & Engng Rev—Sept. 2, 1899. No. 29491.

Baths.

Public Baths. E. Foster. Condensed from a paper read at meeting of the Assn. of Munic. and Co. Engs., at Cardiff. The improvements effected in modern baths are discussed, and the kinds of baths best suited to the general public. 1600 w. San Plumb—Sept. 1, 1899. No. 29527.

Breslau.

Construction of Streets and Buildings in Breslau. Concerning the strictly enforced law regulating the construction of houses and streets, giving some of the requirements. 1000 w. U. S. Cons Repts, No. 530—Sept. 16, 1899. No. 29635 D.

Disinfecting.

The Disinfecting Station at Liverpool. James H. Fuertes. Describes a small plant where infected bedding, clothing and other articles are taken for treatment. 800 w. Eng Rec—Sept. 9, 1899. No. 29640.

Garbage Disposal.

Refuse Destructor Trials, Torquay, England. An account of four tests under different conditions of weather and refuse composition. 1400 w. Eng Rec—Sept. 2, 1899. No. 29469.

The Design of Refuse Carts. Report made by H. Law to the London County Council on the proper construction of these carts. 800 w. Eng Rec—Sept. 16, 1899. No. 29651.

Overflow Chamber.

A Storm Water Overflow, Denver. Illustrates and describes a spillway in connection with the Delganey Street Sewer Extension, and explains its operation. 600 w. Eng Rec—Sept. 9, 1899. No. 29-639.

Paving.

Effect of Moisture on the Results of the Rattler Test of Paving Brick. W. Kendrick Hatt. Reports the results of tests to show less loss when wet than when dry. 900 w. Brick—Sept. 1, 1899. No. 29480.

Some Figures in Brick Paving. H. Foster Bain. Tables giving results obtained in some thirty cities, with an account of methods, materials, etc. 1800 w. Munic Engng—29483 C.

See Street and Electric Tramways.

Purification.

Improved Methods for the Purification of Sewage and Water, as shown in the Operation of the Municipal Plant at Reading, Pa. John Jerome Deery. Part first gives an illustrated detailed description of the sewerage system. 3800 w. Jour Fr Inst—Sept., 1899. Serial. 1st part. No. 29487 D.

Sanitation.

The Renovation of Bombay. Information from the report of the Special City Improvement Trust of Bombay showing energetic efforts to overcome the plague and to render the city healthful. 2000 w. Engr, Lond—Aug. 25, 1899. No. 29434 A.

Septic Process.

A Small Septic and Nitrification Sewage Treatment Plant Near Chicago. Alvord & Shields. An interesting account of the construction and working of a plant for a large golf and polo club house near Chicago. 2000 w. Eng News—Sept. 7, 1899. No. 29560.

Septic Tank and Sewage Filter Beds for the Essex Co. Lunatic Asylum, Verona, N. J. Describes the largest septic tank for the treatment of sewage thus far built in the United States. 750 w. Eng News—Sept. 7, 1899. No. 29-559.

Sewage Disposal.

Modern Methods of Sewage Disposal. William Henry Preece. Extract from address before the Sanitary Inst. of Great Britain, at the Southampton meeting. Considers briefly the mechanical, chemical, and biological systems. 1800 w. Eng News—Sept. 14, 1899. No. 29-621.

Sewer Ventilation.

Some New Theories on Sewer Ventilation. J. Morgan, in *The Surveyor.* Briefly reviews existing systems and describes the method approved by the author. 1200 w. San Plumb—Sept. 1, 1899. No. 29526.

Sprinkling.

Proposed Salt-Water Sprinkling Plant at Oakland, Cal. Plan submitted by M. K. Miller, Supt. of Streets, is presented, with the advantages claimed. 1500 w. Eng News—Sept. 7, 1899. No. 29554.

Street Cleaning.

Street Cleaning Machinery (Ueber Strassenwaschmaschinen). Th. Wayl. A discussion of the importance of washing from the surface of streets all dust and slime, and a description of machines for the purpose. 2000 w. Gesundheits-Ingenieur—Aug. 31, 1899. No. 29838 B.

MISCELLANY.

China.

England, America and Germany as Allies for the Open Door. Hon. John Barrett. Discussing the vast openings for engineering development in China, and the opportunity for the industrial nations which must supply her wants. 4000 w. Engineering Magazine—Oct., 1899. No. 29881 B.

Education.

Engineering Education as a Preliminary Training for Scientific Research Work. Storm Bull. Extracts from an address before the Am. Assn. for the Adv. of Science. On the fitness of the technically trained engineer for scientific research work. 1300 w. R R Gaz—Sept. 15, 1899. No. 29662.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Faults.

Some Interesting Points in the Theory and Practice of "Loop" Testing for Cable Faults. J. Wright. Calls attention to certain modifications and conditions for testing which may assist in obtaining accurate results. Ill. 2000 w. Elec Eng, Lond—Sept. 8, 1899. No. 29687 A.

Condensers.

Compensating Condensers in Telegraph Circuits. M. G. Simpson. Mathematical investigation of currents. 600 w. Elect'n, Lond—Aug. 25. 1899. No. 29456 A.

Signalling.

The Application of Electricity for Transmitting Orders (Ueber die Anwendung der Elektricität für Kommandozwecke). Dr. A. Raps. With numerous illustrations of indicators for transmitting orders from the bridge of a ship to the engine room. 4500 w. Elektrotech Zeitschr—Sept. 7, 1899. No. 29861 B.

Simultaneous Transmission.

Simultaneous Telegraphy and Telephony and the Construction of Apparatus Therefor. H. S. Webb. Considers the fundamental principles involved and describes the methods of arranging the apparatus. Ill. 3300 w. Am Elect'n—Sept., 1899. No. 29502.

Telegraph Lines.

Maintenance and Operation of Telegraph Departments. W. S. Glover. Extracts from a paper read at the July meeting of the Central Assn. of Railroad Officers. Suggestions for construction and repair of lines. 1100 w. Ry Age—Sept. 1, 1899. No. 29481.

Telephone Exchange.

The Independent Telephone Exchange of the LaFayette Telephone Company. Illustrated description of the equipment. 1600 w. Am. Elect'n—Sept., 1899. No. 29501.

Telephone Service.

The Storage Battery in Telephone Exchanges. Illustrates and describes a very successful installation of the Bell Telephone Co., of Philadelphia. 800 w. Elec Wld & Engr—Sept. 9. 1899. No. 29531.

Wireless Telegraphy.

Wireless Telegraphy During the Naval Manœuvres. A brief account of the service messages sent at a maximum distance of 60 sea miles. 500 w. Elect'n, Lond—Sept. 1, 1899. No. 29570 A.

DISTRIBUTION.

Mining Plant.

An Oerlikon Electric Mining Plant in Southern California. An illustrated detailed description of an electric plant for the distribution of power in and about the mines. 1800 w. Elec Wld & Engr—Sept. 23, 1899. No. 29760.

ELECTRO-CHEMISTRY.

Conversion.

The Phenomena Occurring at the Aluminum Anode (Ueber den Vorgang an der Aluminium Anode). K. Norden. A discussion of the subject of the electrochemical conversion of alternating into continuous currents by the use of aluminum anodes. Two articles, 8000 w. Zeitschr f Elektrochemie—Sept. 7, 14, 1899. No. 29866 each H.

Electrolysis.

On the Electrolysis of Thiosulphate of Ammonium. M. P. Pierron. Describes experiments carried out on aqueous solutions of thiosulphate of ammonium containing 17.5 per cent. of the anhydrous salt. 1200 w. Am Gas Lgt Jour—Sept. 4, 1899. No. 29493.

The Electrolysis of the Bromides of the Alkaline Earths (Ueber die Elektrolyse der Bromide der Erdalkalien). J. Šarghel. A very full account of experimental analyses, showing the close relation between the theory and the practical results. Two articles, 8000 w. Zeitschr f Elektrochemie—Sept. 7, 14, 1899. No. 29865 each H.

Furnace.

The Experimental Electric Furnace. Samuel Auchmuntz Tucker. Explains its value in scientific research and illustrates and describes experiments showing the intensity of the heat. 1500 w. Am Elect'n—Sept., 1899. No. 29500.

Statistics.

The Future of Electrochemical Technology (Ueber den Gegenwärtigen Stand der Elektro-chemischen Technik). Dr. W. Borchers. A tabulation of the present applications of electrochemistry, arranged by countries, and processes, together with an exhaustive commentary on the great future possibilities in metallurgy and industrial technology. 2500 w. Stahl und Eisen—Aug. 1, 1899. No. 29830 D.

Voltaic Cells.

Theory of Grotthus Applied to a Simple Voltaic Cell. W. R. Cooper. From a book on Primary Batteries soon to be published by *The Electrician.* Briefly considers the explanation of the main facts of electrolysis, and discusses the reaction in a voltaic cell. Ill. 1700 w. Elect'n, Lond—Sept. 8, 1899. No. 29684 A.

ELECTRO-PHYSICS.

Accumulator.

Batteries for High Pressure (Hochspannungsbatterien). Prof. Feussner. A description of the large storage battery of the Reichsanstalt, at Berlin, intended for a pressure of 10,000 volts. 3000 w. Elektrotech Zeitschr—Aug. 31, 1899. No. 29858 B.

Coherers.

A Quantitative Investigation of the Coherer. A. Trowbridge. Deals with the lowering of the resistance as a function of the quantity of electricity discharged through and the difference of potential on opposite sides of the coherer. 2200 w. Am Jour of Sci—Sept., 1899. No. 29419 D.

Earth Currents.

Cosmical Magnetism and Electricity. Arthur Edgar Cotterell. An examination of magnetic phases, giving illustrative charts. 900 w. Elec Rev, Lond—Aug. 25, 1899. No. 29432 A.

Observatories.

The Interference of Overhead Trolley Wires with the Work of Magnetic Observatories (Verhinderung einer Magnetischen Beeinflussung von Observatorien durch Benachbarte Elektrische Bahnen mit Oberirdischer Stromzuführung). S. Wächter. Referring especially to the action of the trolley lines in Strasburg, Alsace, upon the instruments in the observatory of the university. 1800 w. Elektrotech Zeitschr—Sept. 14, 1899. No. 29863 B.

Symbolism.

Symbolic Representation of General Alternating Waves and of Double Frequency Vector Products. Charles Proteus Steinmetz. A mathematical study of the vector analysis of alternating current phenomena, with discussion. 7000 w. Trans Am Inst of Elec Engs—June and July, 1899. No. 29602 D.

GENERATING STATIONS.

Austria.

The Power Plant on the Adige to Supply Botzen, Meran and Vicinity with Electricity (Die Etschwerke zur Versorgung der Städte Bozen, Meran, und Nachbarorte mit Elektricität). O. von Muller. A fully illustrated description of the plant by which a fall of 66 meters is used to generate 6000 h.p. for lighting, power, and carbide manufacture. 2500 w. Elektrotech Zeitschr—Aug. 31, 1899. No. 29853 B.

California.

The Auburn Station of the Central California Electric Company. Illustrates and describes an auxiliary hydraulic station running in parallel with another five miles away, giving particulars of the buildings and construction. 1000 w. Am Elect'n—Sept., 1899. No. 29499.

The Mount Whitney Water Power Electric Plant and Light Regulating Device. Describes the plant and its device for preventing consumers from burning too many lights. 1800 w. Eng News—Sept. 7, 1899. No. 29556.

Coblenz.

The Power House of the Coblenz Street Railway Company (Das Elektrizitätswerk der Coblenzer Strassenbahn-Gesellschaft in Coblenz). A brief description, with illustrations. 1800 w. Elektrotech Zeitschr—Sept. 7, 1899. No. 29859 B.

Commutation.

Commutation in Iron-Clad Armatures. An illustrated explanation of self-induction, and of how commutation is effected. 1800 w. Engr, U. S. A.—Sept. 1, 1899. No. 29488.

Development.

Water-Power Electrical Plants in the United States. B. C. Washington, Jr. On the great importance of the development, with description of a few important plants, and statistics of interest. 7000 w. Jour Fr Inst—Sept., 1899. No. 29485 D.

Factory Plant.

New Power Plant for the Lancaster Mills. Illustrated description of a three-phase electric power station for a large cotton mill, with a statement of the efficiency of the plant and an editorial on the remodeling of old mills. 3800 w. Eng Rec—Sept. 2, 1899. No. 29468.

Generators.

Direct-Alternating Generators. Alton D. Adams. Gives a brief review of existing conditions in electrical supply, the present tendency, and suggestions for the solution of the central station problem. 2500 w. Elec Wld & Engr—Sept. 9, 1899. No. 29533.

The Dynamos of the Luisenstrasse Electric Station at Berlin (Die Dynamomaschinen in der Centrale Luisenstrasse der Berliner Elektricitäts-Werke). Giving photographic views and scale elevations of the 1,000 kw. generators recently installed. 1000 w. 1 plate. Schweizerische Bauzeitung—Sept. 9, 1899. No. 29837 B.

The Regulation of Alternating-Current Generators. C. L. Cory. Read before the convention of the Pacific Coast Elec. Trans. Assn. at San Francisco. Discusses the drop through the armature, and the change in the strength of the magnetic field due to the demagnetizing action of the armature current. 2700 w. Jour of Elec—Aug., 1899. No. 29796.

King's Lynn.

The King's Lynn Electricity Works. Illustrated detailed description of a gas-driven electric-lighting installation in England. 4500 w. Elec Eng, Lond—Sept. 15, 1899. No. 29793 A.

Lachine Rapids.

Proposed Improvements at Lachine Rapids Works. On schemes proposed for preventing the entrance of ice into the head race, and to otherwise improve the plant. 1500 w. Can Engr—Sept., 1899. No. 29624.

Model Plant.

A Model Electric Light and Power Plant. Illustrates and describes notable features of the plant at Far Rockaway, now part of Greater New York. Ill. 1400 w. Eng News—Sept. 14, 1899. No. 29618.

Short-Circuit.

Experiments on the Short-Circuit Curves of Alternating Generators (Untersuchungen über die Kurzschlusskurve von Wechselstrom generatoren). A. Rothert. A long mathematical discussion with many diagrams based upon original experiments. Three articles. 7500 w. Elektrotech Zeitsch—Aug. 31, Sept. 7, 14, 1899. No. 29854, each B.

Switzerland.

Electric Light and Power Transmission at Aigle, Switzerland. Illustrates and describes an interesting installation showing how the varied wants of consumers are met notwithstanding the long distances and large area of distribution. 1000 w. Engr, Lond—Sept. 8, 1899. No. 29698 A.

Transformation.

A New Method of Determining Ratio of Transformation. J. R. Bibbins. Describes a simple and accurate method that is satisfactory when specially calibrated instruments are not available. 600 w. Elec Wld & Engr—Sept. 9, 1899. No. 29530.

Transformers.

On the Predetermination of the Regulation in Alternating-Current Transformers. A. E. Kennelly. Gives computations showing that the behavior of a transformer, under any given conditions of primary pressure and secondary load, may be predicted with all desired precision when the three transformer impedances have been found. 500 w. Elec Wld & Engr—Sept. 2, 1899. No. 29423.

Zurich.

The Extension of the Zurich Electric Station (Die Erweiterungsbauten des Elektricitätswerkes der Stadt Zürich). H. Wagner. With curves showing the increase in demand, and with views of the engine and boiler house, etc. Three papers. 3500 w. Schweiberische Bauzeitung—Aug. 12, 19, 26, 1899. No. 29835, each B.

LIGHTING.

Arc Lamps.

Iron Poles, Arc Lamps and Wires in Boston. Alton D. Adams. On the dangers to lamp-trimmers, the accidents and their causes, and the action taken by the Massachusetts legislature, which has led to the substitution of poles of wood for those of iron in Boston. 1500 w. Elec Wld & Engr—Sept. 23, 1899. No. 29763.

Cycle Lamps.

Electric Cycle Lamps. J. Warren. The present article deals with the type deriving its current from a storage battery attached to the frame of the machine. 900 w. Elec, Lond—Sept. 8, 1899. Serial. 1st part. No. 29736 A.

Glasgow, Scotland.

Electricity v. Gas in Glasgow. Concerning the charges made to consumers of electric light as compared with gas charges. 1400 w. Gas Wld—Sept. 2, 1899. No. 29575 A.

Incandescence.

Notes on the Incandescent Lamp Question (Beitrag zur Glühlampenfrage). Inspector Loch. An investigation of the endurance and maintenance of illuminating power, and also of the required increase of electrical energy. Tables and diagrams of the tests are given. 3000 w. Glaser's Annalen—Sept. 1, 1899. No. 29834 D.

Wiring.

Electric Lighting Undertakers and House Wiring. W. Fennell. Discusses the position of electric lighting authorities, with respect to wiring and wiring contractors, and with regard to free wiring and allied systems. Also editorial. 3000 w. Elec Engr, Lond—Sept. 1, 1899. No. 29572 A.

MEASUREMENT.

Condenser.

The Behavior of a Condenser of Large Capacity (Ueber das Verhalten eines Kondensators von Grosser Kapacität). Dr. A. Tobler. An account of investigations made with a condenser of 10 microfarads capacity. 1500 w. Elektrotech Zeitschr—Sept. 7, 1899. No. 29860 B.

See Electrical Engineering, Communication.

Conductivity.

The Determination of Standards of

Conductivity. Henry P. Harth. Remarks on the sources of error due to the method now used, with account of the method of using the Willyoung bridge adopted in the laboratory of John A. Roebling's Sons Co., at Trenton, N. J., and a description of new apparatus for determining standard bars of known conductivity. Ill. 1800 w. Elec Wld & Engr—Sept. 23, 1899. No. 29761.

Curves.

A New Apparatus for Showing the Successive Values of Alternating Current Curves (Ein Neuer Apparat zur Objektiven Darstellung der Momentanwerthe von Wechselstromkurven). W. Peukert. Describes an apparatus for showing the elements of the curve simultaneously to an audience by the use of a double form of Deprez mirror galvanometer. 1800 w. Elektrochem Zeitschr—Aug. 31, 1899. No. 29855 B.

Indicator.

A Frequency Indicator. George J. Yundt. Illustrates and describes an instrument based on the using of the repulsive effect of a magnetic field upon a live conductor perpendicular to it. 800 w. Elec Wld & Eng—Sept. 2, 1899. No. 29424.

Network Calculations.

The Equivalence of Triangles and Three-Pointed Stars in Conducting Networks. A. E. Kennelly. Gives a method which lessens the labor of calculating distributing networks. 1000 w. Elec Wld & Engr—Sept. 16, 1899. No. 29643

Permeameter.

A Permeameter for Shop Service. Cecil P. Poole. Gives a design for a permeability testing machine which was found to be thoroughly satisfactory under trying conditions of shop practice. 900 w. Am Elect'n—Sept., 1899. No. 29504.

Report.

The Report of the Physical Technical Institution from February, 1898, to January, 1899 (Die Thätgkeit der Physikalisch-Technischen Reichsanstalt in der Zeit vom 1 Februar, 1898 bis 31 Januar, 1899). A condensation of the full report, especially devoted to electrical measurements and comparisons made during the year. Two articles. 4000 w. Elektrotech Zeitschr—Aug. 31, Sept. 7, 1899. No. 29857, each B.

Resistance.

New Forms of Electrical Resistance Boxes (Neue Formen Elektrischer Widerstandssätze). Dr. Feussner. A description of boxes adapted both for measurement and regulation. 4000 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29852 B.

The Electrical and Mechanical Resistance of Dynamo Brushes. Gives an account of an experimental investigation undertaken in the electrical laboratory of Columbia Univ., by Messrs. Tibbals, Lowenberg, and Burns. The apparatus used is also described. 2800 w. Elec Wld & Engr—Sept. 16, 1899. No. 29645.

Standardization.

Report of the Committee on Standardization. Gives the report accepted by the American Institute of Electrical Engineers on June 26, 1899. 6000 w. Trans Am Inst of Elec Engs—June and July, 1899. No. 29601 D.

Units.

1. On the Rational Suppression of Irrational Systems of Units. E. Hospitalier, *L'Industrie Electrique*. 2. On Electrical Units. E. Blondel. Two communications and editorials discussing the C. G. S. units. 3500 w. Elec Wld & Engr—Sept. 23, 1899. No. 29764.

Wattmeter.

The New Siemens & Halske Wattmeter (Ueber ein Neues Wattmeter der Forma Siemens & Halske, A. G.). Dr. A. Raps. A paper before the Elektrotechnical Society, with numerous illustrations showing the construction of the instrument. 3000 w. Elektrotech Zeitschr—Sept. 14, 1899. No. 29864 B.

POWER APPLICATIONS.

Economy.

The Economy Effected by the Use of the Electric Motor Around Steel Plants, Furnaces and Foundries. Andrew E. Maccoun. States the requirements of power stations of this class, and describes some of the labor-saving devices, showing the advantages gained by the use of electric motors. 2800 w. Elec Wld & Engr—Sept. 9, 1899. No. 29529.

Governor.

Speed Regulator with Electrical Release (Geschwindigkeits regulatoren mit elektrischer Auslösung). H. Müller. A centrifugal governor is arranged to throw a switch in and out of gear to operate mechanism for moving the regulating mechanism of steam or hydraulic motors. 1200 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29850 B.

Machine Driving.

Electric Power in Engineering Works. Dr. Louis Bell. A masterly discussion of the reduction in internal expense and facilitation of shop operations through the use of electric driving. Illustrated by examples of the application of the methods recommended. 4000 w. Engineering Magazine—Oct., 1899. No. 29887 B.

Fly-Wheel Power of Motors. E. K. Scott. The need of thought and judgment in driving certain types of machines. 1000 w. Elec Rev, Lond—Sept. 8, 1899. No. 29686 A.

Starter.

A Simple Starting Device for Polyphase Motors (Ein Einfacher Anlasser für Drehstrommotoren). Dr. F. Niethammer. With diagrams showing the arrangement of resistances adopted by various constructors. 1500 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29851 B.

TRANSMISSION.

Line Wire.

The Sag and Tension of Line Wire. Cary T. Hutchinson. Discusses the problem to determine the sag or tension, showing an error in the procedure generally used, and that the wire can with equal safety be strung much tighter. 600 w. Eng News—Aug. 31, 1899. No. 29407.

Power Transmission.

Three-Phase Power Transmission at St. Hyacinthe, Quebec. E. M. Archibald. Illustrates and describes the oldest plant in Canada employing this system. 2300 w. Can Elec News—Sept., 1899. No. 29525.

Safety Suspension.

Safety Appliance for High Pressure Transmissions (Sicherungen für Hochspannungsanlagen). Conr. Hesse. A description of the Gould device, by which a broken section is automatically disconnected, and rendered harmless. 1000 w. Elektrotech Zeitschr—Aug. 31, 1899. No. 29856 B.

Transmission Line

Tests and Calculations for a Forty-Mile Aluminum Wire Transmission Line. F. A. C. Perrine. Read before the Pacific Coast Elec. Trans. Assn. Reports tests of the line of the Standard Electric Co., of California. 1200 w. Jour of Elec—Aug., 1899. No. 29797.

MISCELLANY.

Cost.

The Cost of Electricity in Some Typical Buildings in New York City. Percival Robert Moses. Shows that the isolated plant can be operated at a profit at rates lower than central station rates. Also discussion. 16800 w. Trans Am Inst of Elec Engs—June and July, 1899. No. 29603 D.

Efficiency.

Theoretical v. Practical Efficiency. Sydney F. Walker. Considers what is meant by efficiency, discussing what he calls the efficiency of transformation and the commercial efficiency. 2000 w. Elec Rev, Lond—Sept. 1, 1899. No. 29574 A.

Electrical Interests.

The Advisability of Concentrating the Control of All Municipal Electrical Interests Under One Head. Morris W. Mead. Read before the Nat. Assn. of Munic. Elect'ns, at Wilmington, Del. Discussion of the subject. 1200 w. Elec Rev, N. Y.—Sept. 6, 1899. Serial. 1st part. No. 29523.

Electrical Work.

The Licensing of Employes on Electrical Work, and Improving the Quality of the Work and Material. William Brophy. Read before the Nat. Assn. of Munic. Elect'ns, at Wilmington, Del. Part first discusses the qualifications of the men occupying important positions and the work undertaken. 2300 w. Elec Rev, N. Y.—Sept. 13, 1899. Serial. 1st part. No. 29616.

Safety.

The Prevention of Injury to Man in Electric Plants (Die Sicherheit des Menschen gegenüber Elektrischen Anlagen). Dr. H. Kath. A discussion of what may be considered normal conditions of safety, and the extent to which such conditions may be violated in electrical plants. 3500 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29849 B.

GAS ENGINEERING

Acetylene.

Acetylene Gas for Lighting. H. L. Tyler. Considers the candle power, generation and cost. Also gives tables, useful in estimating the expense of lighting by acetylene. 1200 w. Dom Engng—Sept., 1899. No 29754 C.

On the Rapidity of Detonation of Acetylene (Sur la Vitesse de Détonation de l'Acétylène). MM. Berthelot and Le Chatelier. A communication to the French Academy giving the results of experiments upon the rate of propagation of ignition at pressures from 5 to 30 atmospheres. 3000 w. Comptes Rendus—Aug. 28, 1899. No. 29840 D.

Researches upon the Metallic Derivatives of Acetylene (Recherches sur les Dérivës Métalliques de l'Acétylène). MM. Berthelot and Delépine. An important communication to the French Academy, giving the detailed results of a long series of experiments. 5000 w. Comptes Rendus—Aug. 14, 1899. No. 29839 D.

Some Drawbacks to the Use of Acetylene. J. Verters, in *Chem. Zeitung.* Calls attention to various inconveniences. 900 w. Sci Am—Sept. 23, 1899. No. 29727.

Coal Distillation.

Coal Distillation and Gas and Fuel Production in Bulk. Extracts from the address of George Bielby, at meeting of the Society of Chemical Industry. Considers the remedies for smoke combustion by the production of smokeless fuels, and the effect of coal distillation. 3000 w. Jour Gas Lgt—Sept. 5, 1899. No. 29606 A.

Coke-Oven Gas.

Illuminating Gas from Coke Ovens. Carl Schmidt, in *Jour. für Gasbeleuchtung*. On tests made in the German coal regions with the conclusion that by using the proper kind of oven and coal an illuminating gas can be made much more cheaply than from retort furnaces and scarcely inferior in quality. 1800 w. Pro Age—Sept. 15, 1899. No. 29633.

The Application of Coke Oven Gas for Motive Power (Die Verwendung der Koksofeugase zum Motorischen Betriebe). A. von Thering. A review of Disdier's paper before the Iron and Steel Institute, giving analyses of many samples of gases. 2500 w. Stahl und Eisen —Sept. 1, 1899. No. 29833 D.

Furnace Gas.

The Direct Utilization of Blast Furnace Gases in Explosion Motors (Utilisation Directe des Gaz des Hauts Fourneaux dans les Moteurs à Explosion). Aug. Dutreux. A general discussion of the subject, based on the paper of Prof. Meyer, of Göttingen. 2000 w. Génie Civil—Aug. 26, 1899. No. 29824 D.

Gas Firing.

Domestic Gas Firing and Its Relation to Heating and Ventilation. Extract from address by George Beilby, at recent meeting of the Society of Chemical Industry, bearing on the present position of this subject. 3500 w. Jour Gas Lgt—Aug. 29, 1899. No. 29507 A.

Gas Traction.

See Street and Electric Tramways.

Lamp.

Illumination by Alcohol (L'Eclairage par l'Alcool). M. L. Denayrouze. A paper before the Society of Civil Engineers of France, describing the use of carburetted alcohol lamps for use in connection with incandescent mantles. 2500 w. Mem Soc Ing Civ de France—June, 1899. No. 29846 G.

Lamp-Black.

Lamp-Black from Coal Gas and Acetylene. Georges F. Jaubert, in *Jour du Gaz et de l'Electricité*. Notes on the industrial preparation of blacks in general and their use, with particulars concerning the beautiful black of exceptional fineness, known as acetylene black. 2000 w. Pro Age—Sept. 15, 1899. No. 29634.

Massachusetts.

The Bay State Gas Situation. An explanation of the present condition and the transactions connected. 3800 w. Am Gas Lgt Jour—Sept. 11, 1899. No. 29-549.

Photometer.

Portable Photometer as Used in the Standard Oil Company's Test. Views and descriptions of an interesting and unique instrument. 600 w. Eng News —Sept. 7, 1899. No. 29551.

Power Gas.

A Study of Various Combustible Gases (Etude sur Divers Gaz Combustibles). M. A. Lencauchez. A critical comparison between producer gas and gas distilled from wood, for heating and power purposes. An important paper. 20000 w. 2 plates. Mem Soc Ing Civ de France—May, 1899. No. 29847 G.

The Production and Use of Combustible Gases (La Production et l'Emploi de Divers Gaz Combustibles). M. Lencauchez. A supplementary communication to the author's previous paper, describing a number of methods of generating gas for heating and power. 7500 w. Mem Soc Ing Civ de France—June, 1899. No. 29848 G.

Pressure.

Notes on the Working of a Self-Loading Governor. W. Whatmough. Read before the Manchester (Eng.) District Institution of Gas Engs. Gives the results of the practical working of the self-loading governor in use at the Heywood Gas Works. Ill. 4700 w. Jour Gas Lgt —Sept. 12, 1899. No. 29740 A.

Separator.

Decauter-Separator for Tar and Liquor. M. G. Ymonet. Read before the Société Technique du Gaz en France, 1899. Abstract. Illustrates and describes the method. 500 w. Gas Wld—Aug. 26, 1899. No. 29430 A.

Supply.

A New Policy in Gas Supply. The policy announced by the High Wycombe Gas Light and Coke Co., which marks a new era in the history of the gas industry. 800 w. Builder—Sept. 16, 1899. No. 29794 A.

Tar.

The Prevention of the Thickening of Tar. Abstract translation of a paper read by Herr G. Siegel before the German Assn. of Gas and Water Engs., at Cassel. States difficulties arising from this trouble, the researches made, and the author's manner of working his retorts, which has resulted in freedom from all troubles arising from thick tar. 3700 w. Jour Gas Lgt—Sept. 5, 1899. No. 29605 A.

MARINE AND NAVAL ENGINEERING

Armament.

Proposed Armament for Our Three Latest Battleships, "New Jersey," "Georgia," and "Pennsylvania," with favorable comment. 1400 w. Sci Am—Sept. 9, 1899. No. 29509.

Auxiliary Machinery.

Electric Auxiliary Machinery in the United States Navy. Alton D. Adams. An examination of the value of electric driving in warships, showing most favorable results. 4400 w. Engr, Lond—Sept. 8, 1899. No. 29697 A.

The Use of Steam Auxiliary Machinery for War Ships. Lieut. J. K. Robison. Reviewing the comparative claims and performance of steam and electric auxiliaries, and giving especial attention to the increase of economy secured by recent improvements in design and operation of steam motors, of which many fine illustrations are given. 5000 w. Engineering Magazine—Oct., 1899. No. 29888 B.

Ballasting.

Ballasting. H. P. Wortley. Written for the Shipmasters' and Officers' Society, London. A discussion of this subject and of the evils of sending ships to sea insufficiently immersed. 2500 w. Naut. Gaz—Sept. 7, 1899. No. 29524.

Battleship.

A New Type of Battleship—The French Henri Quatre. Illustrated description of an experimental ship built by France. 1400 w. Engr, Lond—Sept. 8, 1899. No. 29699 A.

Coast Signals.

Methods Used in Placing the Skeleton Steel Beacon Coast Signals. Brief description of these beacons, designed for use in shoal water as day marks and for survey stations. 700 w. Eng News—Sept. 7, 1899. No. 29561.

Cruiser.

The Austro-Hungarian Cruiser Zenta. Brief description and report of trials of this twin-screw cruiser. Of interest especially as regards the working together of a group of eight Yarrow boilers, which type has been adopted in the Austrian navy for this class of cruiser. Illustrates the triple-expansion engines. 900 w. Engr, Lond—Aug. 25, 1899. No. 29439 A.

The Austro-Hungarian Cruiser Zenta. Illustrates the general arrangement of the boilers and stoke holds. 200 w. Engr. Lond—Sept. 1, 1899. No. 29591 A.

Disaster.

The Bullfinch Disaster. Gives a discussion of the accident to H. M. destroyer Bullfinch, which occurred July 21. 3500 w. Engng—Aug. 25, 1899. No. 29443 A.

The Bullfinch Disaster. Gives a reduced facsimile of the connecting rod and discusses why the rod broke. Deals with the design of the rod and the material. 2800 w. Engr, Lond—Sept. 1, 1899. Serial. 1st part. No. 29589 A.

Dry Docks.

Responsibility of Dry Docks. Concerning a recent case in the Liverpool assize court, which allowed no damages for the collapse of a vessel in dock where exceptional construction had not been provided for. 1300 w. Marine Rev—Sept. 14, 1899. No. 29632.

Germany.

The Development of German Shipbuilding. Rudolph Haack. Herr Haack's third paper deals with the shipyards on the shores of the Baltic, and gives many fine illustrations of yards and their products. 4500 w. Engineering Magazine—Oct., 1899. No. 29882 B.

Marine Engines.

Some Grand Rapids Marine Engines. Baxter Aslakson. The Wolverine gasoline engine is illustrated and described in detail. 2000 w. Am Mach—Sept. 14, 1899. No. 29612.

Marine Machinery.

Test of the Machinery of the Minnesota Steamship Company's Steamer "Pennsylvania." B. C. Bryan and W. W. White. Illustration and general description of the vessel and its equipment, with accounts of the tests for determining the adaptability of underfed stokers and the economic results. 4500 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29392 H.

Naval Manoeuvres.

Outline of the British Naval Manœuvres Recently Concluded. States the purpose of the manœuvres and gives the official programme, with description of the fleets. Ill. 1600 w. Marine Engng—Sept., 1899. No. 29495 C.

Oceanic.

Particulars of the Marine Monsters Oceanic and Great Eastern. Illustrates and describes these two large vessels, giving information of details in the construction of the Oceanic. 2800 w. Marine Engng—Sept., 1899. No. 29494 C.

The "Great Eastern" and the "Oceanic"—A Comparison. An illustrated article bringing out the great progress made during the last forty years in the building of transatlantic liners.

2000 w. Sci Am—Sept. 23, 1899. No. 29726.

The "Oceanic." Illustration and description of the internal fittings of this great White Star Liner. 2500 w. Engng —Sept. 1, 1899. No. 29596 A.

The White Star Twin-Screw Steamer Oceanic. Illustrated description of interior arrangements and decorations. 2000 w. Engr, Lond—Sept. 15, 1899. No. 29783 A.

Propeller Shafts.

The Manufacture of Propeller Shafts. D. B. Morison. Considers the material, workmanship, corrosion, and wearing down of stern bush as the chief factors governing the life of a propeller shaft. Ill. 2500 w. Engng—Sept. 1, 1899. No. 29592 A.

Shipwrecks.

The Shipwrecks of a Year. Editorial on the gross reduction of the mercantile marine in 1898, as given in Lloyd's Registry. 800 w. Engng—Sept. 1, 1899. No. 29595 A.

Signalling.

See Electrical Engineering, Communication.

Steamships.

The Twin-Screw Steamer Bavarian of the Allan Line. Illustration and description of a fine steamer to run between Liverpool and Canadian ports. 1200 w. Engr, Lond—Aug. 25, 1899. No. 29437 A.

Steering.

The Steering of Ship (Ueber das Steuern der Schiffe). C. W. Suppán. An examination into the manner in which the rudder acts upon the water in steering, together with a discussion of modern steering machinery. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 1, 1899. No. 29815 B.

Torpedo Boats.

New U. S. 30-Knot Torpedo Boats Dahlgren and T. A. M. Craven. Dimensions, descriptions, plans, and views of engines. 2800 w. Marine Engng— Sept., 1899. No. 29496 C.

Vibrations.

The Vibrations of Ships, their Causes and Means of Reduction (Schiffsschwingungen, ihre Ursachen und Kritik der Mittel zu ihrer Verminderung). Herr Berling. A general review of the results of investigations made with the Schlick recording apparatus, together with a discussion of the nature of the vibrations, and of the Taylor-Schlick method of balancing engines. Two articles. 2 plates. 10000 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 26, 1899. No. 29800 each D.

Warships

The Logical Arrangement of the Motive Power of Warships. George W. Melville. Full paper, complete discussion and author's reply. 19800 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29-395 H.

Wave Resistance.

A Study of the Energy of the Bow Wave. Marston Niles. The paper presents the writer's reasons for believing that prevailing opinions, with their mathematical basis, are in almost every respect erroneous, and the conclusions therefore incorrect. Considers the transverse bow wave. Ill. 16500 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29393 H.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Automotor Cars.

See Railway Affairs, Motive Power.

Club.

The Automobile Club of France. Francis P. Mann. Gives the history of the club and the work carried out. 2700 w. Elec Rev, N. Y.—Sept. 13, 1899. No. 29615.

Delivery Wagons.

French Trials of Electric Delivery Wagons. Illustrates the two electric wagons that successfully withstood the test made at Versailles. 650 w. Elec Wld & Engr—Sept. 23, 1899. No. 29762.

Hansom.

A New Type of French Automobile Hansom. Illustrates and describes a vehicle exhibited at the recent Exposition in Paris, which is arranged to carry four people and is mounted from the front. 700 w. Elec Wld & Engr—Sept. 16, 1899. No. 29642.

Liverpool Trials.

Auto-Car Trials at Liverpool. Letter to the editor containing remarks and impressions in reference to the hill-climbing trials on July 31. 2200 w. Engr, Lond—Sept. 1, 1899. No. 29588 A.

Parade.

The Automobile Parade at Newport, R. I. Spencer C. Crane. A brief account of this parade with illustrations of the floral decorations. 800 w. Elec Wld & Engr—Sept. 16, 1899. No. 29644.

Steering.

A Study of Double-Pivot Steering Devices (Etude sur la Direction à Deux Pivots). C. Bourlet. A general examination of the various methods of connecting the steering wheels of automobiles, by which the desired varying inclination is obtained. The practice of various builders is given. Two articles. 4500 w. Génie Civil—Sept. 2, 9, 1899. No. 29826 each D.

Tests.

Commission's Report on the Test of Heavy Motor Vehicles. Held at Versailles, in October, 1898. Gives the conclusions of the commission and tabulated report of the tests made. 900 w. Eng News—Sept. 7, 1899. No. 29553.

HYDRAULICS.

Pumping Engine.

The New 20,000-Gallon Pumping Engine of the Indianapolis Water Company. Illustration and report of test made by W. F. M. Goss. 1200 w. Fire & Water—Sept. 9, 1899. No. 29543.

Valves.

Brindley's Hydraulic Working Valve. Illustrates an ingenious invention in pressure valves for use with heavy hydraulic machinery. 600 w. Engr, Lond—Sept. 15, 1899. No. 29787 A.

MACHINE WORKS AND FOUNDRIES.

Axles.

Making Wrought-Iron Axles. Stephen Uren. Read at the convention of the Nat. R. R. Master Blacksmiths' Assn. Describes details in the manufacture of good axles. 1900 w. Ry Age—Sept. 8, 1899. No. 29540.

Brass.

Methods of the Brass Foundry. Extracts from a paper on "The History and Technics of Bronze Founding," read at the Pittsburg meeting by James Powell, indicating that in the making of statues and other cored work the processes of the Greeks and Etruscans were substantially those of to-day. 1000 w. Ir Trd Rev—Sept. 21, 1899. No. 29739.

Chemistry.

Chemistry in Machine Shop Practice. Warren E. Willis. Gives a list of chemicals and their uses in practical work. 2200 w. Mach, N. Y.—Sept., 1899. No. 29399.

Cylinder Boring.

Boring an Engine Cylinder in the Sierra Nevada Mountains. H. H. Kelley. An account of difficulties in starting up a mine engine that had been stopped for more than a year and not left in a proper condition. Ill. 2000 w. Engr, U. S. A.—Sept. 1, 1899. No. 29489.

Dies.

An Automatic Bending Die. H. E. Harris. Illustrated description. 500 w. Am Mach—Aug. 31, 1899. No. 29402.

Making a Compound Watch-Wheel Die. Lundvall and Klute. Illustrated detailed description. 1800 w. Am Mach—Sept. 7, 1899. No. 29515.

Drawing Office.

The Drawing Office. C. E. Hodgkin. Read before the Falcon Works Engng. Soc. On the importance of good delineation, the functions of draughtsmen, etc. 2500 w. Prac Engr—Sept. 1, 1899. Serial. 1st part. No. 29571 A.

Explosions.

Explosions in India-Rubber Works. Editorial discussion of the processes in which carbon bisulphide is used and their danger, and the responsibility of the government. 1700 w. Engng—Sept. 1, 1899. No. 29593 A.

Foundry Practice.

Modern Iron Foundry Practice. George R. Bale. Part first discusses the construction of moulds, and moulding sand. 2300 w. Prac Engr—Sept. 8, 1899. Serial. 1st part. No. 29682 A.

Gears.

Bevel Gear Cutting at the Pope Mfg. Company. Part first illustrates and describes the Brown & Sharpe bevel gear generating machine. 900 w. Ir Age—Sept. 7, 1899. Serial. 1st part. No. 29505.

The Octoid System of Gear Teeth. An illustrated explanation of the term "octoid," and its difference from the involute system. 600 w. Am Mach—Sept. 7, 1899. No. 29513.

Iron Works.

The Union Iron Works. J. Richards. Illustrates and describes the equipment of these works at San Francisco, giving interesting information. 2000 w. Mach, N. Y.—Sept., 1899. No. 29398.

Lathes.

A New English Lathe. James Vose. Illustrates and describes the Tangye engine lathe. 700 w. Am Mach—Sept. 14, 1899. No. 29613.

Loam.

Sweeping a Gear in Loam-Teeth to Be Cut Over After Casting. R. H. Palmer. Gives an illustrated detailed description of the work. 2500 w. Am Mach—Sept. 14, 1899. No. 29611.

Locks.

Ancient Egyptian versus Modern Pin Locks. Illustrates and describes the Egyptian pin lock and the modern Yale lock, showing the improvements made. 1600 w. Sci Am—Sept. 2, 1899. No. 29636.

Machine Driving.

See Electrical Engineering. Power.

Molding.

Molding Columns. R. H. Palmer. Illustrates and describes various methods. 2000 w. Foundry—Sept., 1899. No. 29765.

Premium Plan.

The Premium Plan at the Works of A. L. Ide & Sons. Herman Fernstrom. Describes the system used at these works, considering it more simple than most of the systems presented. 2200 w. Am Mach—Sept. 7, 1899. No. 29514.

Punching.

Punching and Shearing Small Spring Steel. C. E. Quimby. Illustrated description of a sub-press and set of dies for punching and cutting off flat spring-tempered steel about ⅛ inch wide and 1-64 inch thick. 900 w. Am Mach—Sept. 7, 1899. No. 29516.

Shrinkage.

Shrinkage Strains. R. D. Moore. Explains the cause of these strains and discusses the casting of what was known as the Rodman cannon. 1500 w. Foundry—Sept., 1899. No. 29766.

Shop Practice.

The Revolution in Machine Shop Practice. Henry Roland. The first of a series of papers showing the progress of concentration and specialization, and the tendency to use automatic machinery kept in order by skilled tool-makers, but operated by ordinary labor. Illustrations of many historical tools are given in the opening article of the series. 3500 w. Engineering Magazine—October, 1899. No. 29884 B.

Slot Machinery.

Slot Machinery. R. I. Clegg. Explains the coin attachment and its working. 1200 w. Am Mach—Sept. 14, 1899. No. 29614.

Standardizing.

Standardizing in Engineering Construction. Sir Benjamin C. Browne. A forcible statement, by the manager of one of the largest British engineering works, of the changes introduced by widening competition; showing very plainly the direction of mechanical evolution and the necessity for reorganizing works in accord with it. 3500 w. Engineering Magazine—Oct., 1899. No. 29883 B.

Tools.

Some Manchester Tools. James Vose. Photographs and particulars of several machine tools built by Messrs. Beyer, Peacock & Co., Limited, which have attracted attention by reason of their efficiency. 1000 w. Am Mach—Aug. 31, 1899. No. 29400.

Works Management.

The Laws of Profit. R. H. Smith. An examination of the elementary general laws that govern profit-making business. 3500 w. Engr, Lond—Sept. 8, 1899. Serial. 1st part. No. 29695 A.

Works Management for the Maximum of Production. J. Slater Lewis. The first of a series of articles devoted to a discussion of the need and nature of methods to make supervising talent, labor and equipment yield the largest output at lowest cost. 4500 w. Engineering Magazine—Oct., 1899. No. 29885 B.

SPECIAL MOTORS.

Blowing Engines.

Recent Improvements in Power Plants, Especially in Blowing Engines (Neue Aufgaben des Kraft betriebes in Hüttenwerken, insbesondere des Gebläsebaues). A. Riedler. Discussing especially the application of the gas engine to the driving of blast-furnace blowing engines; and the modifications to produce the best results in such cases. 3000 w. Stahl und Eisen—Aug. 15, 1899. No. 29831 D.

Gas Engine.

A Type of Three-Cylinder Vertical Gas Engine. Views illustrating the general construction of the 650-K.-W.-gas-engine which has been operated for some time at the works of the Westinghouse Elec. & Mfg. Co., Pittsburg, Pa., with description. 1000 w. Eng News—Sept. 21, 1899. No. 29751.

Latest Type of Otto Gas Engine. Brief illustrated description of this engine with the latest improvements, adapting it especially to larger sizes. 500 w. Am Mfr & Ir Wld—Aug. 31, 1899. No. 29421.

The Westinghouse Gas Engine. Illustrated description of the more important features of this engine, and its working. Also extract from a pamphlet issued by this company on "The Present Position of the Gas Engine." 2500 w. R R Gaz—Sept. 15, 1899. No. 29661.

Gasoline Engine.

Gasoline Engine, 60 K. W., 220 Volt, Watertown, S. D., Central Station. F. W. Springer. Illustrates and describes a plant consisting of two Otto engines, and explains the conditions which led to this solution of the problem. 1200 w. Elec Wld & Engr—Sept. 9, 1899. No. 29528.

Petroleum-Spirit.

A New Petroleum-Spirit Motor-Vehicle. Brief illustrated description, giving details of some parts of the construction of a vehicle of the four-wheeled dog-cart type. 800 w. Ind & Ir—Sept. 1, 1899. No. 29598 A.

Testing.

Hydrocarbon Engine Testing. Plant of the Ohio State University. William T. Magruder. Presented at the Columbus meeting of the Soc. for the Pro. of Engng. Education. Describes a plant for the testing of gas, gasoline and oil engines as student exercises and research work. 1200 w. Mod Mach—Sept., 1899. No. 29425.

Thermal Engines.

The Diesel Motor and Thermal Engines (Le Moteur Diesel et les Moteurs Thermiques). Donat Banki. An exhaustive discussion of the thermal action of internal combustion and explosion motors, and an inquiry into the conditions which conduce to highest efficiency. An important paper. 4000 w. Génie Civil—Aug. 19, 1899. No. 29821 D.

MATERIALS OF CONSTRUCTION.

Chains.

The Theory and Calculations for Link Chains (Beitrag zur Theorie und Berechnung der Gliederketten). R. Edler. An exhaustive mathematical discussion of the strength of chains made of elliptical links, showing the nature and extent of the stresses and strains, and deriving formulas for practical application. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 18, 25, 1899. No. 29814 each B.

Copper Alloys.

See Mining and Metallurgy, Copper.

Helical Springs.

Carrying Capacity and Deflection of Helical Springs of Round Steel. W. B. Travell. Gives curve diagrams plotted according to the formulæ of J. Begtrup. 350 w. Am Mach—Sept. 21, 1899. No. 29758.

Lubrication.

Graphite and its Application as a Lubricating Material (Grafit und seine Verwendung als Schmiermittel). F. Wagner. A paper giving data concerning the use of graphite in steam cylinders and valve chests of steam engines, showing its value for lubrication. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29806 D.

Metallography.

Notes on the Molecular Constitution of Iron (Einiges über das Kleingefüge des Eisens). E. Heyn. A discussion of some of the latest results obtained by the study of micro etchings of polished sections of iron. Many microphotographs of sections are given. Two papers. 2 plates. 5000 w. Stahl und Eisen—Aug. 1, 15, 1899. No. 29828 each D.

Steel Wire.

The Elastic Properties of Steel Wire. Archer Dave Keigwin. Excerpt from Proceedings of Inst. of Civ. Engs. Describes experiments undertaken to determine the behavior of annealed and unannealed steel wire when subjected to tensile stress. 2000 w. Mech Wld—Aug. 25, 1899. No. 29453 A.

Strength.

The Influence of Temperature Upon the Strength of Metals (Influence de la Temperature sur les Propriété Résistantes des Metaux). A translation into French by M. S. Jordan, of Prof. Ledebur's experiments made at the Charlottenburg testing laboratory. 18,000 w. Bull de la Soc d'Encour—Aug., 1899. No. 29844 G.

Testing Metals.

Work of the International Association for Testing Metals. Mansfield Merriman. Address of the Chairman of the American section of the Assn. at the Pittsburg meeting. Reviews briefly the progress of knowledge concerning the properties of materials of construction, and the formation of the International Association for Testing Materials. 900 w. Mod Mach—Sept., 1899. Serial. 1st part. No. 29426.

POWER AND TRANSMISSION.

Aerial Tramways.

Aerial Tramways in British Columbia. B. C. Riblet. An account of the building and operation of aerial tramways in West Kootenay. 1500 w. Can Min Rev—Sept., 1899. No. 29429 B.

Air Compressor.

A High Grade Australian Air Compressor. Illustrates and describes an air compressor installed at the Long Tunnel gold mine of Walhalla, Victoria. 1500 w. Am Mach—Aug. 31, 1899. No. 29401.

Belts.

Belts. Horace K. Sharpe. Suggestions for their care and regulation. The size of the pulley and speed of the belt in relation to the transmission of power, etc. 2500 w. Engr, U. S. A.—Sept. 15, 1899. No. 29674.

Coal Handling.

A Simple Coal-Handling Equipment. James F. Hobart. Illustrates and describes a portable and easily managed device which is in operation on South street, New York. 700 w. Am Elect'n—Sept., 1899. No. 29503.

Compressed Air.

Compressed Air and its Distribution for Power Purposes in Paris. V. Popp. Deals with how it is produced, its numerous applications and its cost. Ill. 4200 w. Compressed Air—Sept., 1899. Serial. 1st part. No. 29518.

Governor.

See Electrical Engineering. Power Applications.

Power Economy.

Selecting Economical Means for Increasing the Power of a Plant. H. H.

Kelley. Discusses the means of determining whether the installing of a new boiler, the purchase of a larger engine, or the use of a condenser will prove most economical. 2500 w. Engr, U. S. A.—Sept. 15, 1899. No. 29675.

Power Gas.

See Gas Engineering.

Punching.

Power Required for Punching. A reply from Wm. Sellers & Co. to an inquiry for rules or data covering the force and power required for punching iron or steel plates. 600 w. Am Mach—Sept. 21, 1899. No. 29757.

Ropes and Belts.

Transmission of Power by Means of Ropes and Belts. G. H. Thurston. Abstract of paper read before the Mech. Engs.' Assn., Johannesburg. A report of the writer's experience. 2700 w. Ir & Coal Trds Rev—Sept. 1. 1899. No. 29600 A.

STEAM ENGINEERING.

Boilers.

Cleaning Boilers. Suggests means of preventing the formation of scale. 2000 w. Engr, U. S. A.—Sept. 1, 1899. No. 29490.

Boiler Selection.

The Selection of a Boiler. Notes from a memorandum prepared by Charles E. Stromeyer, as to what are the most general demands on a boiler and what boilers are best suited for these purposes. 1200 w. Col Guard—Sept. 1, 1899. No. 29581 A.

Coal Tests.

Comparative Tests of Bituminous Steam Coals. Discussion of paper by John W. Hill. 3000 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29911 E.

Corliss Engine.

Overhauling a Corliss Engine. Charles J. Mason. On the details of practical methods of successfully operating a tandem-compound Corliss condensing engine. Ill. 7000 w. Mod Mach—Sept., 1899. No. 29427.

Dust Fuel.

The Freitag Coal-Dust Firing System (Die Freitagsche Kohlenstaubfeuerung). L. Kauffmann. An illustrated description of an improved system of automatic stoking with finely pulverized coal, as used in sugar refineries at Amsterdam. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 1899. No. 29801 D.

Fuel.

Mr. George Bielby on the Fuel of the Future. Extract from the presidential address before the Soc. of Chem. Ind. Examines the fuel problem in its relation to the smoke question, showing its magnitude and the need of the co-operation of all departments concerned. Ill. 8500 w. Gas Wld—Sept. 9, 1899. No. 29681 A.

Guarantees.

Engine Guaranties. Editorial on the worthlessness of the guarantees usually given. 1700 w. Engr, Lond—Sept. 8, 1899. No. 29702 A.

Reducer.

Pressure Reducing Devices (Druckverminderer). Hr. Randel. With illustrations and descriptions of a variety of reducing valves, and a discussion of the principles on which their action depends. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1899. No. 29803 D.

Rotary Engines.

Improvements in Rotary Engines. Illustrated description of an improved engine designed by T. M. Colwell. 1700 w. Sci Am—Sept. 16, 1899. No. 29608.

Sawmill Engines.

Steam Engines and Boilers for Sawmills. J. L. Crathorne. Describes briefly the most suitable types. 2400 w. Builder—Sept. 16, 1899. No. 29795 A.

Smoke Preventer.

Rossell's Patent Smoke Preventer. Illustrates and describes an apparatus for securing perfect combustion and thus overcoming the smoke nuisance. 1400 w. Prac Engr—Aug. 25, 1899. No. 29431 A.

Smokeless Firing with Bituminous Coal on Passenger Locomotives. A copy of the instructions issued to engine men and firemen on the Cincinnati, New Orleans & Texas Pacific Ry. and accounts of other efforts being made to avoid smoke. 1000 w. Eng News—Aug. 31, 1899. No. 29412.

Thermal Efficiency.

The Thermal Efficiency of Steam Engines. A letter from J. Morrow calls out the discussion given. 3500 w. Engr, Lond—Sept. 1, 1899. No. 29585 A.

Valve Gear.

Electrically Operated Valve Gear—Is it a Simplification or a Complication? Robert A. Bruce. Discusses the effort being made to replace the Corliss valve gear by electrically operated valves, and thinks it doubtful whether economy or convenience can be secured in this way. 1600 w. Am Mach—Aug. 31. 1899. No. 29403.

Vertical Engine.

Vertical Steam Engine of 3000 Horse Power (3000-pferdigen Vertikalen Ventildampf-machine). An illustrated description of the triple-expansion Sulzer engine built for the Luisenstrasse electric station at Berlin. Three articles. 2 plates. 3000 w. Schweizerische Bauzeitung—Aug. 12, 19, 26, 1899. No. 29836 each B.

MISCELLANY.

Address.

British Association: Mechanical Science Section. William White. Review of progress made in steam navigation; the causes of advance in speed of steamships, and length of voyages; also considers the prospects for further advance. 11000 w. Engr, Lond—Sept. 15, 1899. No. 29785 A.

American Machinery.

American Machinery in the United Kingdom. Interesting information from a British engineer concerning the amount of American machinery used and its value, the conditions of labor in the United Kingdom and related matter. 2500 w. U. S. Cons Repts, No. 535—Sept. 22, 1899. No. 29752 D.

Evaporator.

The Lillie Evaporator. Illustrated description. 900 w. Engng—Sept. 15, 1899. No. 29790 A.

Liquid Air.

Concerning Liquid Air Companies. Editorial on the number of companies and their claims, promises and offers of stock, with cautions to investors. 2000 w. Eng News—Sept. 14. 1899. No. 29619.

Liquid Air as an Explosive. Frederick H. M'Gahie. Some points of interest in regard to a trial in progress in Europe, in which liquid air is being used at one end of a tunnel being put through the Alps, and the usual explosives at the other end. 1000 w. Sci Am—Sept. 16, 1899. No. 29607.

Object Lessons.

The Lens and Pencil in Mechanical Engineering. A. B. Willits. Discusses the advantage of graphically representing details in machinery, the use of curves and sketches, the use of photographs, etc. Ill. 2500 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29396 H.

Patents.

The German Patent Law and the German Patent No. 80974 (Das Deutsche Patentgesetz und das Deutsche Reichspatent Nr. 80974). Hr. Lüders. A discussion of the suit for the annulment of the Schlick patent for balancing steam engines, including a review of the policy of the German courts in such cases. Two articles. 18000 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 26, 1899. No. 29802 each D.

Research.

The Field of Experimental Research. Elihu Thomson. Vice-Presidential address delivered at the Columbus meeting of the Am. Assn. for the Adv. of Science. On the limitations which past discoveries place upon experimental inquiry. giving experimental suggestions. 5500 w. Elec Wld & Engr—Sept. 9, 1899. No. 29532.

Trade Schools.

Mechanics, their Relation to Each Other and to Mechanical Industries—Trade Schools. John E. Sweet. Excerpts from an address delivered at Rochester, N. Y. On the apprenticeship feature of the mechanical industries, and trade schools. 3700 w. Am Mach—Sept. 7, 1899. No. 29512.

MINING AND METALLURGY

COAL AND COKE.

Coal Handling.

See Mechanical Engineering, Transmission.

Coal-Mines.

Improvements of the Spring Valley Coal Mines. J. A. Ede. A fire having destroyed the shaft of their mines and set fire to the mines, it became necessary to sink a new shaft. The conditions are explained and the improvements described and illustrated. 5700 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29707 D.

Coal Tests.

See Mechanical Engineering, Steam Engineering.

Explosions.

Gas Enclosed in Coal and Its Effect on Coal-Dust Explosions. Dr. Broockmann, in *Glückauf*. What the gases are and the amount of them in various coals. 4000 w. Mines & Min—Sept., 1899. No. 29464 C.

Invoices.

Colliery Invoices and the Purchase of Colliery Stores and Materials. George Johnson. On the outward and inward invoices of colliery companies, showing the position of storekeeper to be one of responsibility and importance. 2700 w. Col Guard—Sept. 1, 1899. No. 29578 A.

Lignite.

The Lignite Deposits in the Cologne District (Das Braunkohlenvorkommen in der Kölner Bucht). H. Dobbelstein. A very complete description of these extensive workings, with map and several sections. 4500 w. 2 plates. Glückauf—Sept. 9, 1899. No. 29868 B.

Michigan.

Coal Mining in Michigan. Charles Holmes. Describes the quality of the coal and the extent of the coal field as shown by exploration and development, and gives a brief description of the mines which have been opened and some of the causes of their successes and failures. 5800 w. Mines & Min—Sept., 1899. No. 29461 C.

Mineral Fuels.

Fuel Examination by X-Rays. M. Couriot. Gives the principles of this method for determining the impurities in mineral fuels, describing the apparatus and manner of preparing the samples, giving illustrations showing the results from various fuels. 3000 w. Mines & Min—Sept., 1899. No. 29458 C.

New Brunswick.

The Coal Deposits of the Province of New Brunswick. Describes the Grand Lake coal mines mainly. 1400. Ir & Coal Trds Rev—Sept. 15, 1899. No. 29780 A.

North Staffordshire.

The Re-Survey of the North Staffordshire Coalfield. Concerning the progress made, and information gained. 4500 w. Col Guard—Sept. 1, 1899. No. 29579 A.

Semet-Solvay.

The Manufacture of Coke by the Semet-Solvay Process. A consideration of this process, the extent to which it is used, the results of working, etc. Ill. 2200 w. Col Guard—Sept. 15, 1899. No. 29772 A.

COPPER.

Copper Alloy.

A New Hot Malleable Alloy of Copper. From a specification for an alloy of copper which may be rolled or otherwise worked at a red heat and have the necessary degree of hardness for general use. The invention of Johannes Catharinus Bull, a Swede, living in London. 450 w. Am Mach—Sept. 21, 1899. No. 29756.

The Strength of Copper and Copper Alloys at High Temperatures. Extracts from an article by George Charpy describing tests made. 900 w. Prac Engr—Sept. 15, 1899. No. 29770 A.

Copper-Deposits.

The Copper-Deposits of Vancouver Island. William M. Brewer. Gives information gained by the writer while examining and developing some of these prospects. 1800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29711 D.

GOLD AND SILVER.

Arrastra.

The Arrastra. Arthur Lakes. Illustrates and describes an ancient and effective device for treating ores, which can be cheaply constructed in inaccessible regions. 1200 w. Mines & Min—Sept., 1899. No. 29462 C.

Chile.

The Mines and Mill of the Atacama Mineral Company, Ltd., Taltal, Chile. Sidney H. Loram. An account of the work carried on by this company. Ill. 4800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29720 D.

Cyanide.

The Chemistry of the Cyanide Process. J. Ohly. Considers mainly the effect of copper and its ores and the cause and mode of determining its presence. 1500 w. Min Rept—Sept. 21, 1899. Serial. 1st part. No. 29798.

Gold Fields.

Snake River Gold Fields of Idaho. Don Maguire. Describes the river and its tributaries, discusses the sources of the very fine gold and the methods of obtaining it. 4000 w. Mines & Min—Sept., 1899. No. 29460 C.

Gold Mine.

Topeka Gold Mine at Central City, Colorado. Arthur Lakes. A description of the peculiar formation of the veins found there. Ill. 3000 w. Mines & Min—Sept., 1899. No. 29463 C.

Mexico.

The Cebollitas Camp, Chihuahua, Mexico. Describes the mines of this camp, so rich in mineral wealth and so perfect in climate that work can be carried on all the year. 900 w. Eng & Min Jour—Sept. 23, 1899. No. 29759.

The Santa Elena Mine, Mexico. Illustrates and describes this mine, the development work, surface equipment, cyanide plant, etc. 1200 w. Eng & Min Jour—Sept. 2, 1899. No. 29415.

Ore-Deposits.

The Peculiar Ore-Deposit of the East Murchison United Gold Mine, Western Australia. D. P. Mitchell. Describes and illustrates the structural features, mineralization and development. 900 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29716 D.

Production.

The Gold Production of the World. Statistics for the year 1898, showing a further increase over the high point attained the previous year. 1200 w. Eng & Min Jour—Sept. 2, 1899. No. 29414.

Prospecting.

Value of the Diamond Drill for Prospecting. H. M. Lane. On the amount of dependence which can be placed upon the record furnished by it. Ill. 1900 w. Mines & Min—Sept., 1899. No. 29457 C.

Slimes.

A Continuous Process of Slimes Treatment. A contribution to the discussion of paper by Ernest T. Rand. 1200 w. Jour of Chem & Met Soc of S Africa—July, 1899. No. 29452 E.

Smelting.

Notes on Silver Losses in Smelting. Malvern W. Iles. Discusses the conditions and causes. 4000 w. Eng & Min Jour—Sept. 9, 1899. Serial. 1st part. No. 29535.

South Africa.

Some Notes on the Mining Practice of the Witwatersrand Goldfields, South African Republic. G. A. Denny. Describes the general features of the deposits, the mining methods, etc. 5500 w. Sch of Mines Quar—July, 1899. Serial. 1st part. No. 29522 D.

The President's (Mr. John R. Williams) Inaugural Address. Reviews the work of the past few years in the recovery of gold, and the improvements made. 2200 w. Jour of Chem & Met Soc of S Africa—July, 1899. No. 29-451 E.

Tellurium.

Tellurium and Tellurides. Describes the character of these ores and the importance of their occurrence, in connection with a recent discovery in South Australia. 2000 w. Aust Min Stand—July 27, 1899. No. 29625 B.

Transvaal.

Mining on the Witwatersrand to 12,000 ft. Deep. John Yates. Abstract of a paper recently read before the S. African Assn. of Engs., with editorial. Considers the question of working the banket beds at deeper levels than have been yet attempted. 5000 w. Eng & Min Jour—Sept. 16, 1899. No. 29658.

IRON AND STEEL.

America.

American Iron Developments. A review of existing conditions and recent changes in the iron industry of America. 2000 w. Engr, Lond—Sept. 1, 1899. No. 29587 A.

Bertrand-Thiel.

An Explanation of the Rapidity of the Bertrand-Thiel Process. Henry M. Howe. An explanation of the changes made in the various steps of the process is given. 1600 w. Eng & Min Jour—Sept. 2, 1899. No. 29416.

Blast Furnace.

Blast Furnace and Cupola Practice. Edgar S. Cook. Paper read before the Philadelphia Foundrymen's Assn. Discusses the use of casting machines for foundry iron, the improvements in blast furnace practice, the points of resemblance between blast furnace and cupola practice, etc. 3400 w. Foundry—Sept., 1899. Serial. 1st part. No. 29767.

The Relative Desulphurizing Effect of Lime and Magnesia in the Iron Blast-Furnace. O. R. Foster. Describes laboratory experiments carried out in the metallurgical laboratory of Columbia University, New York, to determine the desulphurizing action of lime-magnesia silicates when fused together with sulphurous cast-iron. 1800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29-715 D.

Canada.

Canadian Mining Project. An account of what it is expected will prove one of the largest iron and steel enterprises in the world. 900 w. U. S. Cons Repts, No. 538—Sept. 26, 1899. No. 29908 D.

Carburized Iron.

The Present Position of the Solution Theory of Carburized Iron. A. Stansfield. Read before the British Iron and Steel Inst. An explanation of the main features of this theory and its relation to the allotropic changes. 3800 w. Ir & St Trds Jour—Sept. 9, 1899. No. 29738 A.

Casting Machine.

A New Casting Machine for Blast Furnaces. Richard Hanbury Wainford. Read at the Manchester meeting of the Iron and Steel Inst. In regard to a new mechanical apparatus for casting sandless pig iron in insulated moulds, so as to maintain a good crystalline fracture, at a reduced cost. Ill. 1400 w. Engng—Aug. 25, 1899. No. 29445 A.

Coke Oven.

The Bauer By-Product Coke Oven. Illustrated description of ovens claiming the advantages of surplus of gas unconsumed, smaller space, low working expenses, and absence of smoke. 1400 w. Eng & Min Jour—Sept. 9, 1899. No. 29536.

Diffusion.

The Diffusion of Elements in Iron. John Oliver Arnold and Andrew McWilliam. Read at London meeting of the Iron and Steel Inst. Gives important facts and describes experimental methods which brought out the results presented. Ill. 3500 w. Engng—Aug. 25, 1899. Serial. 1st part. No. 29446 A.

Great Britain.

The Iron Trade Situation in Great Britain. J. S. Jeans. Comments on the statistics of the British Iron Trade Assn., for the first six months of 1899. 1700 w. Ir Age—Sept. 21, 1899. No. 29725.

Iron Industry.

The Outlook in the American Iron Industry. Archer Brown. A definite, comprehensive summary of the conditions and influences producing the recent extraordinary advance affecting the present situation, and determining the future course of production and prices. Reviews authoritatively the export movement and its future. 4500 w. Engineering Magazine—Oct., 1899. No. 29886 B.

Lake Superior.

The Lake Superior Iron Ore Mines and Their Influence Upon the Production of Iron and Steel. J. Head and A. P. Head. Read before the Inst. of Civ. Engs. (British). The writers visited this district to satisfy themselves concerning the competition to be expected, and to investigate the mines, ores, means of mining, loading and unloading and transporting. Part first describes the region, its topography and geology, the mining methods, mines, etc. Ill. 4400 w. Col. Guard—Sept. 8, 1899. Serial. 1st part. No. 29692 A.

Magnetic Iron.

Cape Breton Island and Its Magnetic Iron Deposit. Martin A. Macpherson. Brief account of the island and its immense wealth, the ore deposits, quantity, smelting, etc. 2200 w. Ir & Coal Trds Rev—Aug. 25, 1899. No. 29449 A.

Magnetites.

A Brief Review of the Titaniferous Magnetites. J. F. Kemp. Reviews and summarizes what is known of the occurrences of the titaniferous magnetites in different parts of the world, giving a series of analyses illustrating the ranges in composition. 8500 w. Sch of Mines Quar—July, 1899. Serial. 1st part. No. 29519 D.

Manganese.

The Rar-el-Maden Mine of Manganiferous Iron (La Mine de Fer Manganésifère de Rar-el-Maden). E. Dietz. An account of the mine near Oran, Algiers, from which a valuable spiegeleisen ore is obtained. 2000 w. Rev Univ des Mines—Aug., 1899. No. 29843 G.

Pig-iron.

The Make and Stocks of Pig-iron in the First Half of 1899. Statistics concerning the production of pig-iron, and pig-iron stocks, with a statement of the condition of the furnaces in the United Kingdom. 1000 w. Ir & Coal Trds Rev —Sept. 8, 1899. No. 29688 A.

Rod Rolling.

Notes on Rod Rolling and Its Development. N. K. Turnbull. Read before the West of Scotland Iron and Steel Inst. Considers chiefly the rolling of rods under ½ in. in diameter. Reviews the progress in this branch of rolling-mill work, the systems used and improvements made. 5500 w. Ir & Coal Trds Rev—Aug. 25, 1899. No. 29448 A.

Statistics.

The Iron and Steel Industries of the World. From the summary prepared by James M. Swank for the United States Geological Survey. 4000 w. Col Guard —Aug. 25, 1899. No. 29441 A.

The World's Iron Output. J. Stephen Jeans. A short account of the iron-trade situation in Europe, and the bright outlook for the southern states in America. 2000 w. Am Mfr & Ir Wld—Sept. 7, 1899. No. 29534.

Steel.

The Make of Open-hearth and Bessemer Steel in the United Kingdom in the First Half of 1899. Statistics collected by the British Iron Trade Assn. 800 w. Ir & Coal Trds Rev—Sept. 8, 1899. No. 29689 A.

Steel Plates.

Some Results of Transverse and Tension Tests of Steel Plates. Abstract of report given by W. K. Hatt at meeting of the Am. Sec. of the International Assn. for Testing Materials. Interesting and valuable information. 1200 w. R R Gaz —Sept. 8, 1899. No. 29565.

Tinplates.

The Manufacture of Tinplates—Past and Present. W. C. Cronemeyer. Describes the work and processes used. 3500 w. Ir & Coal Trds Rev—Aug. 25, 1899. No. 29450 A.

MINING.

Accidents.

Mining Employment and Accidents in 1898. From the report of the British Home Office on mines and quarries. Summary of information on employment in mines and quarries, and accidents of the year. 2500 w. Ir & Coal Trds Rev —Sept. 8, 1899. No. 29690 A.

Air Currents.

The Control of Air Currents in Gaseous Mines. Considers the mode of treatment necessary, stating conditions often found and the remedies. 900 w. Am Gas Lgt Jour—Sept. 18, 1899. No. 29672.

Balance Sheets.

The Balance Sheet of a Mining and Manufacturing Company. George Johnson. Describes in some detail the various assets and liabilities of the balance-sheet. 3800 w. Ir & Coal Trds Rev—Sept. 1, 1899. Serial. 1st part. No. 29599 A.

Cages.

Sliding Doors for Mine Cages. From *Zeitschrift für Berg, Hutten-und Salinenwesen.* Illustrated description. 750 w. Col Guard—Sept. 15, 1899. No. 29775 A.

Drill-Holes.

Determining the Deflection of Drill Holes. G. C. McFarlane. Illustrates a device which will determine the amount and direction of a drill hole's deflection at any point, which the writer believes to be more accurate than the methods in use. 500 w. Eng & Min Jour—Sept. 16, 1899. No. 29659.

Explosives.

The Development of the Manufacture of Explosives in Austro-Hungary (Die Entwicklung der Sprengmittel-Industrie in Oesterreich-Ungarn). F. Hess. With much interesting information about the properties and composition of mining explosives. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 11, 1899. No. 29-813 B.

Fans.

Note as to the Theory of Fans. S. Hanappe. From a communication to the Société des Ingénieurs des Mines du Hainaut. Mathematical demonstrations showing the applicability of Bernouilli's theorem to the motion of air between fan vanes. 1500 w. Col Guard—Sept. 15, 1899. No. 29778 A.

Gas.

Outbursts of Gas at Lancashire Collieries. John Gerrard. Communication to the Geological Society. Describes the outburst in the Westleigh colliery in December last, and also an outburst in the Arley Mine, Welch Whittle, in 1897. 1300 w. Col Guard—Sept. 15, 1899. No. 29774 A.

Hoisting Engine.

The Tamarack Mining Company's New Hoisting Engine. An illustrated detailed description, with editorial on hoisting engine development. 2500 w. Am Mach—Sept. 7, 1899. No. 29511.

Inspection.

The Periodical Inspection of Mines by Workmen. Extracts from a summary of the Prussian Government Commission, which visited, England, Belgium and France to obtain information as to the working of this system. 1400 w. Col Guard—Sept. 8, 1899. No. 29694 A.

Lamps.

The Safety of the Electric Miners' Lamp as Compared with the Ordinary Miners' Lamp. Sydney F. Walker. Maintains that the general adoption of electric portable lamps would lead to decreased accidents and lower working costs. 2200 w. Col Guard—Sept. 15, 1899. No. 29773 A.

Madagascar.

Mining in Madagascar. From the report of F. W. Turner. Iron, copper, silver, and lead have been discovered, and also tin. Gives some points on French mining laws. 900 w. Engr, Lond—Sept. 8, 1899. No. 29700 A.

Mining Law.

Arbitration Clauses in Mining Leases. Adjudications and essential facts relating to decisions pronounced in the Supreme and Appeal Courts of England, and in the Court of Session of Scotland. 3000 w. Col Guard—Sept. 1, 1899. No. 29-576 A.

Mining Machinery.

Abuse of Mining Machinery. D. L. Howard. Read before the Ohio Inst. of Min. Engs. Calls attention to a few of the abuses and injuries and the disadvantages under which the machinery is worked. 1300 w. Can Min Rev—Aug. 31, 1899. No. 29428 B.

Machine Coal-Cutting in 1898. Edward W. Parker. Postscript to a paper on "Coal-Cutting Machinery," presented at the New York meeting. 1000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29714 D.

Recent Silesian Mining Machinery (Neuere Bergwerksmaschinen Schlesischer Werke). H. Dubbel. Especially describing and illustrating some large underground pumping engines of recent design, with details of the valves, and indicator cards from the steam and water cylinders. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1899. No. 29-808 D.

The Lee Long-Wall Mining Machine. H. Foster Bain. A description of this machine, which is simple in operation and applicable to a wide range of long-wall work. Ill. 2500 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29719 D.

Mining Plant.

The Surface Plant of the French Rand Gold Mining Co. (Installation de Surface des Mines d'Or de la French Rand Gold Mining Co.). J. Dupont. A general account of the stamp mills, cyanide plant, and other surface works of the French Rand Co., at Johannsburg. 2500 w. 1 plate. Génie Civil—Aug. 26, 1899. No. 29823 D.

See Electrical Engineering, Distribution.

Primitive Mining.

Primitive Mining in Staffordshire. A brief account of the early mining in this district. 900 w. Col Guard—Sept. 1, 1899. No. 29582 A.

Pump.

The Kaselowsky Drainage Pump (La Machine d'Epuisement Système Kaselowsky). C. François. Describing a subterranean pump operated by hydraulic pressure and used for mine drainage. 3000 w. 2 plates. Rev Univ des Mines—Aug., 1899. No. 29842 G.

Pumping.

Pumping Difficulties in the Maypole Colliery Sinking. J. Keen. Abstract of paper read before the Manchester Geol. Soc. Describes difficult work and the appliances used. Ill. 3700 w. Ir & Coal Trds Rev—Sept. 15, 1899. No. 29779 A.

Rescue Appliances.

Apparatus for Re-charging Rescue Appliances with Oxygen. J. Mayer, in *Oesterreichische Zeitschrift für Berg und Huttenwesen.* Illustrates and describes an apparatus for re-charging the oxygen bottles by compressing the oxygen, so as to obtain the gas under maximum pressure even when the cylinder pressure has diminished. 1000 w. Col Guard—Sept. 1, 1899. No. 29580 A.

The Charging of Oxygen Cylinders for Life-Saving Apparatus (Vorrichtungen zum Nachfüllen der Sauerstoff-Flaschen bei den Rettungsapparaten). Joh. Mayer. Describing methods of charging the oxygen reservoirs of portable devices for use in gaseous mines. Two articles. 4000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 19, 26. 1899. No. 29867 each B.

Safety.

Safety Appliances for Hoisting Machines (Sicherheitsvorrichtung für Fördermaschinen). C. Budil. A description of the Wodrada apparatus, recently installed in Moravia, by which any excess in speed of the cage gives an alarm in the engine room. 1000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1899. No. 29-809 D.

Schools.

Correspondence Schools. R. P. Rothwell. Discussion of this paper. H. H. Stock's reply to Mr. Rothwell's criticisms. 2000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29717 D.

Shafts.

Automatic Shaft-Closing Arrangement at a Westphalian Colliery. From *Glückauf.* Illustrates a simple and original design which has proved satisfactory. 400 w. Col Guard—Sept. 1, 1899. No. 29-577 A.

Sinking a Shaft with Means for Taking Off the Water. From *Glückauf.* Illustrates and describes the Tomson water-raising arrangement. 800 w. Col Guard—Sept. 15, 1899. No. 29776 A.

Surveying.

The Evolution of Mine-Surveying Instruments. Discussion of this paper by Dunbar D. Scott. Ill. 7300 w. Trans Am Inst of Min Engs—Oct., 1898. No. 29721 D.

Timbering.

Systematic Timbering in Mines. Discussion of a movement in England to insist on the systematic timbering of mines, showing that such an order would only increase expense and tend to diminish the safety. 800 w. Col Guard—Sept. 8, 1899. No. 29693 A.

Tubbing.

Repairs to a Shaft Tubbing at a Westphalian Colliery. From a communication by Ingenieur Schulte to *Glückauf.* Longitudinal and transverse sections showing the method by which the water inburst was eventually kept back and the shaft made tight. 1600 w. Col Guard—Aug. 25, 1899. No. 29440 A.

Ventilation.

Influence of Natural Ventilation in Mines Ventilated Artificially. A discussion of the effect, which either adds to the force or is antagonistic, and the necessary allowance to be made. 900 w. Col Guard—Sept. 15, 1899. No. 29777 A.

Water Power.

The Utilization of Drainage Water to Work a Turbine Driving a Winch. An illustrated account of a turbine installation in a French colliery. 800 w. Ir & Coal Trds Rev—Sept. 8, 1899. No. 29691 A.

Workings.

Cooling Down Warm Working Places Under Ground. Bergassessor Tübben, in *Glückauf.* Proposes a method of cooling down by means of liquid air. 1400 w. Col Guard—Sept. 1, 1899. No. 29584 A.

MISCELLANY.

Amalgamation.

Note on Plate-Amalgamation. Allan J. Clark. Gives results of experiments made on the large plate-surface in the mills of the Homestead Company, to determine whether silver gave evidence of a tendency to escape amalgamation. 700 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29712 D.

Calciner.

The Latest Type of Mechanical Calciner. W. Blackmore. Read before the Institution of Mining and Metallurgy. Describes the Godfrey Mechanical Calciner, designed to calcine zinc and leady-zinc ores. 1900 w. Ir & St Trds Jour—Sept. 9, 1899. No. 29737 A.

Diamonds.

The Occurrence of Diamonds in New South Wales. A report by D. C. McLachlan, Under-Secretary for Mines and Agriculture, Sydney, N. S. W. Thinks the diamond-mining industry destined to become important in these areas. 1400 w. Jour Soc of Arts—Sept. 8, 1899. No. 29676 A.

Laboratories.

The Equipment of Metallurgical Laboratories. Henry M. Howe. Discusses mainly the value of laboratory work for undergraduate students, but thinks it of great benefit to advanced students and all who wish to investigate metallurgical problems. 3000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29710 D.

Metallurgy.

Metallurgical Processes (Metallhüttenwesen). C. Schnabel. The first of a series of metallurgical articles; this installment is devoted to roasting furnaces for copper ores. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1899. No. 29-810 D.

Metallography.

See Mechanical Engineering, Materials.

Mexico.

Notes on the Geology of Sonora, Mexico. E. T. Dumble. Gives results of geological investigations. 11800 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29722 D.

Mica.

Occurrence of Mica in South Norway. J. F. Wells. Condensed from a paper before the Inst. of Min. and Met. Describes a mica mine in Norway, showing remarkably coarse crystallization of some of the minerals. 1300 w. Min & Sci Pr—Aug. 26, 1899. No. 29397.

Minerals.

Minerals of the Southern States. From an account prepared by the Southern Railway of the United States. Facts and figures concerning coal, iron, manganese, corundum, copper, bauxite and aluminum ore. 4200 w. Ind & Ir—Aug. 25, 1899. No. 29433 A

Ores.

On the Separation and Determination of Arsenic and Antimony in Ores. O. C. Beck and H. Fisher. Compares the different known methods in order to determine which is the shortest and most accurate. 2200 w. Sch of Mines Quar—July, 1899. No. 29521 D.

Rock-Salt.

Rock-Salt in Louisiana. A. F. Lucas. An account of localities known, with particulars concerning the development of the deposits, giving illustrations and details not heretofore published. 4200 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29709 D.

Rocky Mountains.

Notes on the Structure of the Rocky Mountains in the Lewis and Clarke Timber Reserve, Montana. Robert H. Chapman. Description with map. 1300 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29713 D.

Smelting.

A Furnace for Smelting Zincy Lead Ores. Ludwig Kloz. Drawings and description of a furnace designed to meet special conditions. 800 w. Eng & Min Jour—Sept. 2, 1899. No. 29417.

Tin Field.

Herberton Tin Field (Q.). Arthur Babington. Information concerning these deposits in North Queensland, and their workings. 2200 w. Aust Min Stand—Aug. 3, 1899. Serial. 1st part. No. 29-626 B.

Tin-Ore.

The Occurrence of Tin-Ore at Sain Alto, Zacatecas, with Reference to Similar Deposits in San Luis Potosi and Durango, Mexico. Edward Halse. Describes the various workings and compares them with deposits named. Ill. 2400 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29718 D.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in July. Detailed list and classified summary. 4500 w. R R Gaz—Sept. 22, 1899. No. 29746.

Railroad History.

The Pennsylvania Railroad Fifty Years Ago. Facts concerning the first scheduled train, and the building of this road. 600 w. R R Gaz—Sept. 15, 1899. No. 29-666.

LEGAL.

Texas Law.

Judicial Construction of the Texas Anti-Rebate Law. Gives the construction of Judge Howard Templeton of the District Court at Sulphur Springs. 1600 w. Ry Age—Sept. 8, 1899. No. 29538.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Westinghouse Air Brakes on Russian Railways. Translation of the ministerial order requiring all standard Russian railways to equip their freight cars and engines with the Westinghouse air brakes by Jan. 1, 1903. 2200 w. U. S. Cons Repts, No. 531—Sept. 18, 1899. No. 29-673 D.

Automotor Cars.

Automotor Cars for Railways. Describes and illustrates the "hydro-carbon" car tried at Columbus, Ind., and gives schemes for the transformation of Italian railways. 1500 w. Transport—Aug. 25, 1899. No. 29455 A.

Axles.

See Mechanical Engineering, Machine Works.

Chapel Cars.

Chapel Cars on Railroads. Rev. C. H. Rust. Illustrates and describes these cars and the work which they do. 1000 w. Ry & Engng Rev—Sept. 16, 1899. No. 29670.

Dining Cars.

Modern Dining Cars for the Southern Railway. Plan and interior views, with description of carefully arranged and handsome cars. 700 w. Ry & Engng Rev—Sept. 9, 1899. No. 29548.

New B. & O. Dining Cars. Plan and views, with brief description. 200 w. R R Gaz—Sept. 8, 1899. No. 29563.

Draft Rigging.

The Dayton Draft Rigging. Illustrates and describes three applications of a new draft rigging designed by Edward Grafstrom. 700 w. R R Gaz—Sept. 1, 1899. No. 29406.

Hot Bearings.

The Use of Water on Hot Bearings of Engines and Tenders. Extracts from the committee report presented by Charles A. Crane to the Traveling Engs. Assn. Gives replies to circular letter of inquiry. Information favors the use of water. 1100 w. Ry & Engng Rev—Sept. 16. 1899. No. 29668.

Locomotive Erection.

Rapid Locomotive Erection in France. Illustrations and information on the quick erection of a locomotive in one of the shops of the Eastern of France Railway. 900 w. Engng—Sept. 1. 1899. No. 29597 A.

Locomotives.

A New Lackawanna Locomotive. Engraving and dimensions of a new locomotive recently built at the Scranton shops of the Delaware, Lackawanna & Western Railroad. 350 w. Ry Age—Sept. 8, 1899. No. 29539.

Cooke Ten-Wheel Freight Locomotive, Oregon Short Line. Half-tone view and description. 900 w. Ry & Engng Rev—Sept. 2, 1899. No. 29492.

Locomotives Built at the Old Haigh Foundry. Clement E. Stretton. An account of engines built from 1835 to 1856. 1800 w. Mech Wld—Sept. 15, 1899. No. 29792 A.

New Atlantic Type Locomotives on the Canadian Pacific. Engraving, description and a brief of the specifications. 600 w. R R Gaz—Sept. 15, 1899. No. 29665.

Pennsylvania Class F 1-A Freight Locomotives. Illustration and brief description. 250 w. R R Gaz—Sept. 22, 1899. No. 29744.

Pneumatic Locomotives. A. E. Kyffin. Explains the main features of pneumatic locomotives and their working, the cost, and advantages. 1900 w. Prac Engr—Sept. 15. 1899. No. 29771 A.

The Illinois Central's New Locomotive. Illustrated description of a 12-wheeled consolidation engine that up to date is the largest and heaviest locomotive in the United States. 900 w. Ry Age—Sept. 22, 1899. No. 29768.

United States Competition in the Locomotive Export Trade. Part first discusses locomotive building, giving extracts from a recent article in the *Engineering News*, with comments. 3000 w. Engr, Lond—Sept. 15, 1899. Serial. 1st part. No. 29781 A.

Locomotive Tests.

Tests of English Express Locomotives. Discusses points brought out by a series of trials of different types of express locomotives. Also editorial on train resistance, lessons drawn from the results given. 2700 w. R R Gaz—Sept. 15, 1899. No. 29663.

Rolling Stock.

The Rolling Stock of the Great Central Railway. Illustrates and describes details in the design of new cars. 2200 w. Engng—Aug. 25, 1899. No. 29442 A.

Springs.

Locomotive Driving Springs. Editorial discussion of the proper methods of shop treatment. 900 w. Ry & Engng Rev—Sept. 16, 1899. No. 29671.

Ventilation.

A Plan for the Ventilation of Railway Carriages (Ein Vorschlag zur Ventilation Fahrender Eisenbahnwaggons). Dr. A. Hinterberger. A description of a method by which air is forced through a small pipe and delivered into the compartments of each carriage through a number of perforations. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 11, 1899. No. 29812 B.

NEW PROJECTS.

Africa.

Cape Railways. A review of the year ending Dec. 31, 1898, as given in the annual report. 700 w. Engr, Lond—Aug. 25, 1899. No. 29436 A.

China.

An All-British Railway to China. C. A. Moreing. Notes some of the changes the Siberian Railway will effect, and considers the advisability of Great Britain carrying a continuous line from the Mediterranean to the Yang-tze. 3800 w. Nineteenth Cent—Sept., 1899. No. 29631 D.

Notes from Newchwang. J. Grant Birch. Deals with the Eastern Chinese railway and other engineering works. Ill. 2500 w. Engng—Sept. 15, 1899. No. 29789 A.

Honduras.

Proposed Railroad in British Honduras. A proposal of British capitalists for the construction and working of a railway from Belize to Guatemala. 1000 w. U. S. Cons Repts, No. 529—Sept. 15, 1899. No. 29630 D.

Jungfrau.

The Jungfrau Railway. Gives a description of the line so far as it is built, its operation and equipment. 3800 w. Engng—Sept. 8, 1899. No. 29706 A.

Manchuria.

The Manchurian Railway. Editorial comment on the Russian Imperial order declaring Talienwan a free port. 1200 w. Engng—Sept. 1, 1899. No. 29594 A.

Rhodesia.

Rhodesia and Its Railways. Extracts from a pamphlet recently published by the British South African Co. On the rapid development of the last ten years, giving interesting facts relating to the railways. Ill 900 w. Transport—Sept. 8, 1899. No. 29677 A.

Siberia.

Work on Siberian Railway. Translation of an article from the *Novoe Vremia.* On changes that must be made to meet the unexpected traffic, and giving a brief description of the road. 800 w. U. S. Cons Repts, No. 524—Sept. 9, 1899. No. 29517 D.

West Africa.

The Sierra Leone Railway. An interesting account of the construction of the road, with many illustrations. 3000 w. Engr, Lond—Sept. 8, 1899. No. 29701 A.

PERMANENT WAY AND FIXTURES.

Boston Station.

Back Bay Station of the New York, New Haven & Hartford. Describes a new way-station, Italian Renaissance in architectural style. 750 w. R R Gaz—Sept. 8, 1899. No. 29564.

The New South Station of the Boston Terminal Company. H. W. Weller. History and illustrated description of this fine station, also illustrations of abandoned stations of the roads now brought into this one train-shed. 2400 w. Am Arch—Sept. 16, 1899. Serial. 1st part. No. 29660.

Bumping Posts.

Concrete Bumping Posts, C. R. I. & P. Ry. Describes and illustrates a superior post consisting of a concrete pier 10 ft. long, 4½ ft. wide, and 9 ft. deep, reaching 4 ft. below the surface. 500 w. Ry & Engng Rev—Sept. 9, 1899. No. 29547.

Car Shops.

The New Car Shops of the John Stephenson Company, Ltd. Charles Henry Davis. Historical sketch and illustrated detailed description with other information. 4500 w. Eng Rec—Sept. 23, 1899. Serial. 1st part. No. 29901.

English Railway.

The Great Central Railway from Leicester to Rugby. Illustrates and describes the Braunstone Gate bridge and other features of the permanent way. 3200 w. Engr, Lond—Sept. 1, 1899. No. 29586 A.

Frogs.

Hinged Switch and Cast Steel Frog; Netherlands State Railways. Illustrates and describes two interesting features of track construction. 500 w. Eng News —Sept. 7, 1899. No. 29555.

Improvements.

Improvements in Alignment and Grades, C. B. & Q. Ry. Illustrates and describes heavy and extensive work. 2400 w. Ry & Engng Rev—Sept. 23, 1899. No. 29906.

Oil Stations.

Oil Stations in Russia. From "Apercu des Chemins de Fer Russes." Illustrated description. 800 w. Ry Age—Sept. 1, 1899. No. 29482.

Rail Breakage.

The Breakage of Steel Rails. Editorial review and criticism of paper by W. G. Kirkaldy, published by the Inst. of Civ. Engs., England. 1800 w. Eng News—Aug. 31, 1899. No. 29410.

Rail-Sections.

Important Results Obtained in the Past Fifteen Years with the Stiff and Heavy Rail-Sections. Dr. P. H. Dudley. Discussion of this paper. Ill. 2400 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29708 D.

Station Grounds.

Improvement of Station Grounds at Mechanicville, N. Y., D. & H. Ry. Illustrated description of recent improvements effected. 1000 w. Ry & Engng Rev—Sept. 9, 1899. No. 29544.

Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Discussion of paper by W. W. Curtis. 1000 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29914 E.

Track Forces.

Reorganization of the Track Forces on the Ohio River Railway. Gives particulars of a new system of dividing the labor in track maintenance, arranged to provide a more thorough inspection of track and economy in track repairs. Also editorial. 2500 w. Ry & Engng Rev—Sept. 9, 1899. No. 29545.

Track-Laying.

Holman-Burke Track-Laying Machine on the "Soo Line." Describes and illustrates an improved machine in use on the Minneapolis, St. Paul and Sault Ste. Marie Ry. 1600 w. Ry & Engng Rev. Sept. 9, 1899. No. 29546.

Tracks.

Modern Developments in Track and Track Work. E. E. Russell Tratman. Abstract of an address delivered before the Roadmasters' Assn. of America, at Detroit. Remarks on improvements and features which depart somewhat from usual practice. 3000 w. Eng News—Sept. 21, 1899. No. 29748.

Relation of Track to Traffic. B. R. Coates. Read before the Roadmasters' Assn. of America. Discusses this subject and gives the opinion that the track conditions are not proportionate to the load and stress. 1800 w. Ry & Engng Rev—Sept. 16, 1899. No. 29669.

Steel Foundations for Steam Railroad Track. Gustav Lindenthal. Considers the substitution of metal cross ties for those of wood, and heavier and harder rails for the lighter rails in use. 3000 w. R R Gaz—Sept. 8, 1899. Serial. 1st part. No. 29562.

The Spotting and Grooving Machine—Flint & Pere Marquette Ry. Illustrated description of a device for the cutting and evening of the rail seats on the ties as they lie in the track. 1600 w. Ry & Engng Rev—Sept. 23, 1899. No. 29907.

Track Scales.

Arrangement of Track Scales—Chicago, Lake Shore & Eastern Railway. Illustrates a highly satisfactory arrangement, the distinctive feature of which is the ease of operation and the handling of the cars. 600 w. R R Gaz—Sept. 15, 1899. No. 29664.

Tunnels.

The Ventilation of Tunnels. Francis Fox. Condensed from a paper read before the Inst. of Civ. Engs., England. Describes the systems in use in various tunnels and the results. Long discussion. 7500 w. Eng News—Aug. 31, 1899. No. 29408.

The Ventilation of Tunnels (Ventilation des Tunnels). R. Godfernaux. The first paper of a series treating very thoroughly of the conditions involved in tunnel ventilation, both from a practical and theoretical standpoint. Data from numerous existing tunnels are given. Serial. Part 1. 2500 w. Génie Civil—Aug. 19, 1899. No. 29822 D.

Viaducts.

Railway Viaducts in Cornwall, Old and New. T. H. Gibbons. A general description of the old viaducts, placing them under two classes; those carried on timber trusses, supported for the most part on timber piles which form the piers; and those over valleys when good foundations are to be had. Also describes the new viaducts. Ill. 3500 w. Inst of Mech Engs—1899. No. 29724 D.

See Civil Engineering, Bridges.

TRAFFIC.

Freight Classifications.

Efforts to Unify the Freight Classifications. J. W. Midgley. On the course that should be adopted to carry the movement to successful completion. 2500 w. Ry Age—Sept. 15, 1899. No. 29667.

Grain-Rate Decision.

The Latest Grain-Rate Decision. Editorial discussion of Commissioner Prouty's opinion on export and domestic rates. 1500 w. R R Gaz—Sept. 8, 1899. No. 29568.

Statistics.

Poor's Railroad Statistics. Editorial comment on information furnished in the introduction to "Poor's Manual" for 1899. 900 w. R R Gaz—Sept. 8, 1899. No. 29567.

Tonnage.

Some Results of the Use of Tonnage Statistics. Gives a practical example of the use of ton-mile statistics as a means of economy. Documents sent to the editor by Mr. Kruittschmitt of the Southern Pacific. 3800 w. R R Gaz—Sept. 1, 1899. No. 29404.

STREET AND ELECTRIC TRAMWAYS.

Address.

President's Address to the Street Railway Association of the State of New York, at Ithaca. G. Tracy Rogers. Touching many subjects of interest, showing the great advancement of the past year in street railway development. 5500 w. St Ry Rev—Sept. 15, 1899. No. 29728 C.

Combined Operation.

Combined Operation of Trolley and Steam Systems on the Long Island Railroad. Illustrates and describes some features of the experiment in operating the Rockaway Beach division of this road. 1400 w. Elec Wld & Engr—Sept. 2, 1899. No. 29422.

Compressed Air.

Compressed Air Traction in New York City. Illustrates and describes the compressing engine, which is of interest on account of its size and power, and the high working pressure. 1800 w. Sci Am—Sept. 16, 1899. No. 29609.

Costs and Profits.

Comparative Costs and Profits of Cable, Electric and Horse Traction in New York City. Receipts and expenses of the Metropolitan Street Railway Co., of New York City, for the year ending June 30, 1899, as compared with the previous year. 1800 w. St Ry Jour—Sept., 1899. No. 29478 D.

Coventry.

Coventry Electric Tramways. Illustrated detailed description of a successful English tramway. 3500 w. Tram & Ry Wld—Sept. 7, 1899. No. 29742 A.

Electric Railways.

Revolution of the Present Railway System by the Advent of the Elevated Electric Railway. A. Davis. Discusses the steam surface railway and its progress and expense, and the elevated electric railway as an improvement, noting the road about to be built between Liverpool and Manchester, Eng. 2300 w. Can Engr—Sept., 1899. No. 29623.

Employees.

How Can We Increase the Efficiency of Employees? F. D. Rounds. Read before the N. Y. St. Ry. convention. Discusses wages, selection of applicants, education, treatment, and chances of promotion. Discussion follows. 3300 w. St Ry Rev—Sept. 15, 1899. No. 29729 C.

Gas Traction.

Gas Traction on the Blackpool, Lythom and St. Anne's Trams. W. Chew. Read before the Manchester (Eng.) District Inst. of Gas Engs. Describes the route, station and appliances and working, giving some results. 1300 w. Jour Gas Lgt—Sept. 12, 1899. No. 29741 A.

In Defence of Gas Traction and the Latest Example. Concerning the new installation at Neath, and stating some of the advantages. 1700 w. Jour Gas Lgt—Sept. 5, 1899. No. 29604 A.

Glasgow.

Engines for Glasgow Tramways. From the *Glasgow Herald.* A discussion of the facts and considerations relating to this contract, with an account of the Allis type of engine. 3300 w. Am Mfr & Ir Wld—Sept. 21, 1899. No. 29755.

Glasgow Corporation Tramways. Text of Mr. Parshall's specification in so far as it refers to the construction of the main engines, with editorial discussion of the American tenders. 6200 w. Engr, Lond—Aug. 25, 1899. No. 29438 A.

The Contract for the Engines of the Municipal Electric Railways of Glasgow, Scotland. Editorial review of the controversy in Great Britain over the recent action of the Town Council of Glasgow in connection with the bids for four 4,000-H. P. and two 800-H. P. engines. 3700 w. Eng News—Sept. 21, 1899. No. 29749.

The Glasgow Tramway Contracts. Editorial review of the trouble in connection with 'the contracts for the engines for the electric tramways. 2200 w. Engng—Aug. 25, 1899. No. 29444 A.

The Glasgow Tramways Contract. G. L. Addenbrooke. A letter to the editor giving a very interesting explanation of the present position of electrical engineering in Great Britain. 2300 w. Engr, Lond—Sept. 8, 1899. No. 29705 A.

Hamburg.

Electric Street Car System of Hamburg. Interesting information of the construction and management of what is claimed to be the most complete system on the Continent. 1800 w. U. S. Cons Repts. No. 518—Sept. 1, 1899. No. 29413 D.

Hartford.

"Kinks" from Hartford. Illustrates and describes recent additions to the power station and other improvements. 2400 w. St Ry Jour—Sept., 1899. No. 29477 D.

Kashmir Railway.

Kashmir Electric Railway Scheme. Concerning a project brought forward by M. Nethersole, State Engineer, for working the line by electricity, and adopting a route differing considerably from previous plans. Maps. 1300 w. Elec Rev, Lond—Sept. 8, 1899. No. 29685 A.

Marseilles.

The New Permanent Way of the Marseilles Tramways (Les Nouvelles Voies des Tramways de Marseille). A. Magnier. With sections of the rails, details of the joints and bonding, and views of the switches and curves. 2500 w. Revue Technique—Aug. 25, 1899. No. 29827 D.

Massachusetts.

A Cross Country Electric Railway in Eastern Massachusetts. An illustrated detailed account of the Norfolk Western Street Railway Company, with general introductory information. 3300 w. St Ry Jour—Sept., 1899. No. 29472 D.

Mechanical Traction.

Dr. Kennedy on Mechanical Traction for the London Tramways. Review of report of Dr. A. B. W. Kennedy furnished for the guidance of the London County Council. 2000 w. Jour Gas Lgt—Aug. 29, 1899. No. 29506 A.

Northern Ireland.

The Portrush and Giant's Causeway Electric Railway. Brief description, with illustrations of an electric railway eight miles long, the first constructed in the United Kingdom. 900 w. Engr, Lond—Sept. 8, 1899. No. 29703 A.

Paving.

The Paving Question. T. J. Nicholl. Read before the N. Y. St. Ry. convention. Considers the injustice in requiring the street railways to keep the pavement in repair. 2200 w. St Ry Rev—Sept. 15, 1899. No. 29731 C.

Power Distribution.

Railway Power Distribution Over Large Areas. A. H. Armstrong. Read before the N. Y. St. Ry. convention. Describes the system adopted by the International Traction Co. for the operation of the various roads in Buffalo and vicinity. 1800 w. St Ry Rev—Sept. 15, 1899. No. 29732 C.

Power Station.

Power Station of the Metropolitan Street Railway Company. Brief illustrated description of the Ninety-sixth station, with map showing location of this and the sub-stations. 800 w. St Ry Jour—Sept., 1899. No. 29479 D.

Rail Bonds.

Bonding Electric Rail Tracks. W. G. T. Goodman. Read at meeting of the Elec. Assn. of New South Wales. Describes the various systems of bonding, and the damage and loss incurred through defective bonding. 2300 w. Aust Min Stand—Aug. 10, 1899. Serial. 1st part. No. 29627 B.

Electric Welding. R. F. Danforth. Read before the N. Y. St. Ry. convention. Describes the process used by the Johnson Co. in welding the rails of the Buffalo Ry. Co. 2000 w. St Ry Rev—Sept. 15, 1899. No. 29730 C.

Experiments on Rail Bonds. Henry H. Norris. Read before the N. Y. St. Ry. convention. The importance of this subject is discussed, the difficulty of keeping the bonding in good condition, poor bonding, inspection, etc. 2000 w. St Ry Rev—Sept. 15, 1899. No. 29734 C.

Repairs.

Practice in the Repair Shops of the Chicago City Railway Company. Illustrates and describes a trolley-wheel turning device, a machine for splitting rattan, coil taping stands and bobins, baking coils, etc., etc. 4800 w. St Ry Jour—Sept., 1899. No. 29475 D.

Practice in the Repair Shops of the North Chicago Street Railway Company. Deals with the cutting of gears and pinions, use of copper, motor cranes, armature testing device, fenders and other safety devices. Ill. 1800 w. St Ry Jour—Sept., 1899. No. 29474 D.

Rolling Stock.

New Rolling Stock for Liverpool Tramways. Illustrates and describes the new top-seat motor cars which are being supplied. 700 w. Tram & Ry Wld—Sept. 7, 1899. No. 29743 A.

Sheffield, Eng.

Sheffield Corporation Tramways. Illustrated detailed description. 2700 w. Elect'n, Lond—Sept. 1, 1899. No. 29569 A.

Splicing Cars.

Splicing Cars in Philadelphia. Illustrates and describes the splicing of two short cars together to make a long car. 250 w. St Ry Jour—Sept., 1899. No. 29476 D.

Statistical Data.

Some Electric Street Railway Data. Harris J. Ryan. Read before the N. Y. St. Ry. convention. Average of answers to questions sent to plants in the United States concerning the construction and operation. 1500 w. St Ry Rev—Sept. 15, 1899. No. 29733 C.

Storage Battery.

The Englewood & Chicago Storage Battery Line. An account of a successful storage battery line which has been in operation more than two years. Ill. 1800 w. St Ry Jour—Sept., 1899. No. 29473 D.

Switzerland.

The Burgdorf-Thun Railway. Illustrated description of an interesting electrically-driven heavy railway, 25 miles long, with a 16,000-volt overhead transmission, and overhead distribution to the train of three-phase current at 750 volts pressure. 1400 w. Elect'n, Lond—Sept. 8, 1899. Serial. 1st part. No. 29683 A.

Trolley Wires.

The Influence of Temperature Upon the Wires of Electric Tramways (Ueber den Einfluss der Temperatur auf den Fahrdraht Elektrischer Bahnen). Dr. M. Eisig. A discussion of the stresses produced by expansion and contraction. 2000 w. Elektrotech Zeitschr—Sept. 14, 1899. No. 29862 B.

Underground Wiring.

Underground Wiring of the Toledo Traction Co. Illustrates description of the work of placing underground the lighting mains and feeder wires in the business district of this city. 1400 w. St Ry Rev—Sept. 15, 1899. No. 29735 C.

THE
ENGINEERING MAGAZINE
VOL. XVIII. DECEMBER, 1899. No. 3.

SOUTH AFRICAN QUESTIONS FROM AN ENGINEERING STANDPOINT.

By Albert Williams, Jr.

The Vaal River.

SO much has been printed and read about South Africa during the past three years, and more especially in recent months and weeks, that an extensive, if somewhat superficial, mass of information has been disseminated. It is not necessary, therefore, even if it were possible in a brief review of the situation, to enter into details, though it may be worth while to glance at some of the more salient features. Readers of THE ENGINEERING MAGAZINE have had very thorough accounts of the technical aspects of gold mining and metallurgy in the Transvaal, by Messrs. Hammond, Webb, Yeatman and Holmes in issues during 1898 and by Dr. Hatch in that for August, 1899. To these publications reference should be had for precise statements. Newspaper reports have been voluminous, in part illuminating, in part confusing. The purpose of the present paper is to supplement those of the well-informed authorities cited, by a more general consideration of the conditions from an outside point of view.

Historically, little need be said here; yet a rapid glance backward is not without interest. While the ocean route from western Europe

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Cecil Rhodes, according to Mr. W. T. Stead, thinks it is the Supreme will that he should "paint as much of the map of Africa British red as possible, and * * * promote the unity and extend the influence of the English-speaking race." Whatever the immediate incident,

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ZULU WAR DANCE.

to the Orient by way of the Cape of Good Hope had long been of great importance, from the days of the early Portuguese, Dutch, and English navigators down to recent times (although latterly affected disadvantageously by the competition of the Suez-Canal route), little definite was known of South Africa to the outside world until quite recently, except what pertained to a mere fringe of coast and a few refuges and refitting points for shipping. True, the migration, in the seventeenth century, of large numbers of Dutch settlers, with a sprinkling of French Huguenots who were impelled thither by a love of political and religious freedom, had brought in a sparse population which spread from the Cape gradually toward the interior. Later, on the general redistribution of territory following the Napoleonic wars in 1815, Great Britain, which had held, abandoned, and reannexed Cape Colony, came into possession of an additional tract of territory now known as Natal, but with indefinite boundaries to the north. A fresh influx of settlers then came in. Long after this the white population was still very scanty in proportion to the vast indeterminate area and to the numerous native races. All these earlier white settlers, though adventurous, hardy, and persistent, did little to develop the vast country, being engaged almost wholly in grazing and to a less degree in

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the assured outcome of the present struggle will fulfill Mr. Rhodes' definition of his purpose; but the highest significance of the result will be economic, and not political. It will mean, first, an enormous impetus to industries already established when stable and equitable government replaces the rule of monopoly and repression. Next and greatest, it will mean the firm fixation and rapid on-moving of the greater scheme for a well-ordered, busy, prosperous, vastly-productive and vastly-consuming Anglo-Saxon empire on the erstwhile "Dark Continent." No one who is engaged in supplying the world with the tools of industry and progress can be less than absorbingly interested in the situation and its outcome. THE EDITORS.

agriculture of a primitive order—pursuits very useful and necessary, but hardly progressive.

Almost from the outset of the British occupation of Cape Colony there was friction between the two main classes of settlers, who, though distinctly of the same generic stock, failed to assimilate in the friendly manner of the Dutch and English in the settlement of New Amsterdam, called New York after the transfer. The Boers have always claimed, and honestly believed, that they were oppressed; which assertion impartial history cannot be said to have sustained. Great Britain, at least for more than a century, and also at least as regards her white subjects, has been scrupulously careful in dealing with colonial affairs. In this instance, one grievance seems to have been as to the abolition of slavery, which was suppressed at about the same period in the British West Indies on a similar adjustment. The Boers, however, were incensed on not receiving compensation satisfactory to them. This, combined with many other and pre-existing causes, real and imaginary—(such as extreme love of personal and national independence, racial antipathy, divergent customs and ways of thought) led to the further dispersion of the Boers northward, and, about sixty years ago, to the great trek into the then almost unknown desert. In this wilderness were established the Orange Free State and the Transvaal, more correctly called the South African Republic. The relations between these republics (especially the last named) and Great Britain have been at times more than strained, as witness the first Boer war in 1881. However, the differences were patched up after a fashion in 1884, partly on account of trouble with the Zulus, and the frontier was delimited, so that for a time the outlook seemed peaceful enough.

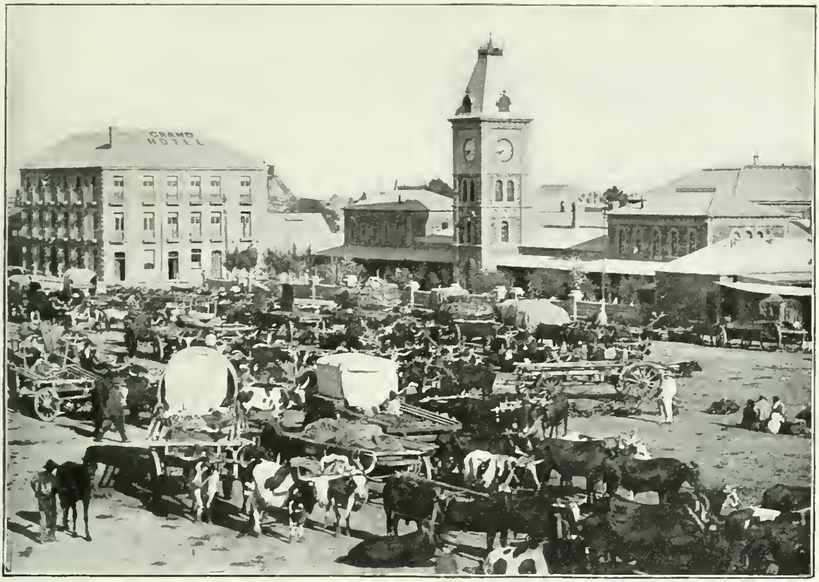
THE VELDT NEAR KIMBERLEY. THE COUNTRY AS THE BOERS FOUND IT.

WITCH DOCTORS

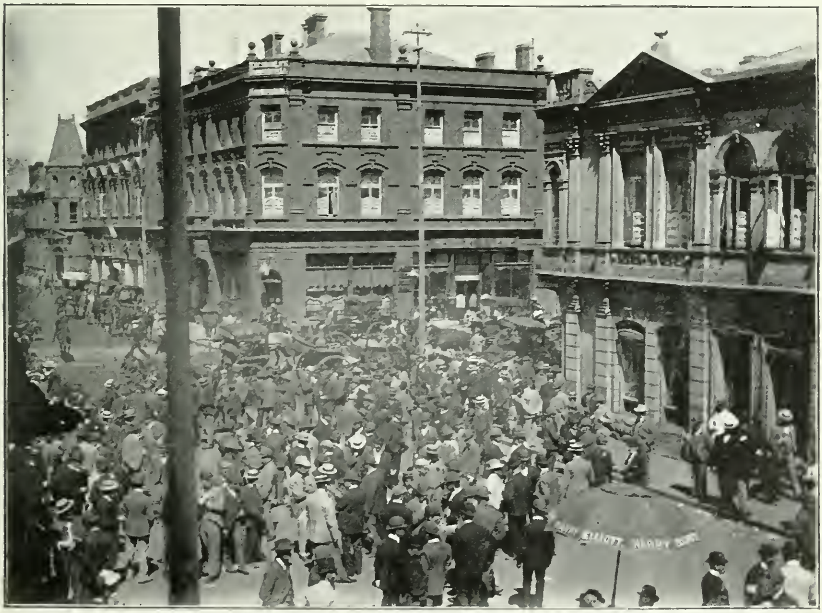
The much debated, misty and intangible question of suzerainty need not have created difficulties; the boundaries were clearly defined, and the Boers were left to themselves to work out their own evolution. This state of affairs might have continued indefinitely, or until the inevitable advance of the higher civilization should efface existing lines, had not entirely new and unforeseen industrial conditions arisen. The discovery of diamonds in Cape Colony and the Orange Free State marked one stage in the new order of things. It led to an immediate inrush of adventurers, mainly British. In itself it was not a source of instant trouble, for the number of whites for whom there was no employment in the diamond workings and in subsidiary occupations was limited. But the pushing newcomers—at first the overplus of those disappointed in the diamond fields, reinforced by others who had there succeeded and had means to undertake fresh enterprises—began to spread over neighboring Boer territory. Meanwhile gold discoveries, of both placers and lodes, had been made in various localities of South Africa. These, while not largely productive as measured by the great outputs of more favored districts, were sufficiently promising to attract large numbers of prospectors who began to over-

A NATIVE BARBER.

A CAPE CART.



THE MARKET PLACE, KIMBERLEY.



"BETWEEN THE CHAINS." A JOHANNESBURG STREET SCENE.

A large amount of the trading in mining stocks is done on the street, and a section of this particular street is enclosed with chains during certain hours of the day.

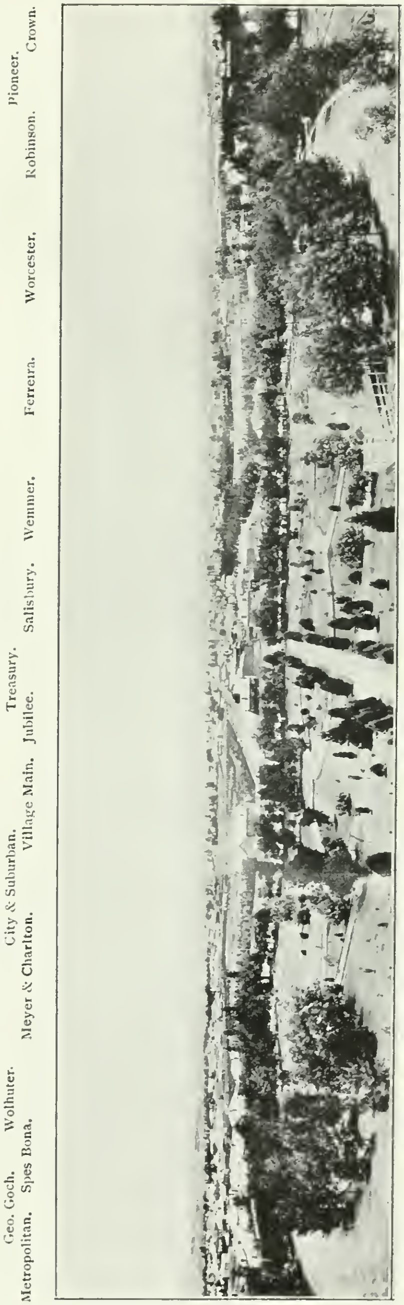
run well nigh the whole of South Africa, including the two Boer republics.

As some one has put it, this was the irony of fate—that finally, after all the toil and danger and abnegation, they should have been led to the region most alluring to the cupidity of the hated Uitlander. The realization of this did not come at once and as a shock, but by degrees. It was not until 1885 that gold-bearing conglomerate beds of the Witwatersrand, in the Transvaal, were discovered, and it was not until some time later that the almost fabulous richness of the region was fully appreciated. At first, restrictive and prohibitory laws were enforced against prospecting for and mining gold. Then, when it seemed hopeless to stave off the inevitable, and in the endeavor to make the best of the situation, a reversal of policy ensued. The Transvaal government saw the opportunity to replenish its empty treasury by means of taxing gold mining, directly and indirectly, and even went so far as to offer a bonus for the discovery of paying gold deposits. In Mr. Hammond's opinion this latter move acted as an immediate incentive to prospectors and was an efficient factor in the rapid growth, not only of the revenue, but of gold mining and its allied industries. Sooner or later, discoveries were bound to come; but it is worthy of note that the Transvaal government itself encouraged them and thereby tacitly but impliedly entered upon obligations which

PREMIER OPEN DIAMOND MINE.

no amount of argument can disguise. This feature is neither admitted nor recognized generally—certainly not by the Boers themselves.

At the same time it is possible—though the point is not altogether clear—that the Transvaal authorities expected not only to augment their revenues, but also, by taxing gold mining up to the limit which it could bear, to frame a double-acting policy which should promote mining to a certain extent and there restrict it. Such an explanation would be in harmony with the shrewdness accredited to the Boer managers: yet it is a policy which has overreached itself. Prior to the outbreak of hostilities the gold output had been brought up to a rate of over $75,000,000 a year. This is much less than the possible annual yield which could be had in the near future and could be maintained for a long period. The exactions imposed were such as to retard natural development. While investors stood ready to extend greatly the workings and to increase plant, the political uncertainties and doubt as to the financial policy of the South African Republic and its posture towards the mines have deterred them; so that, although there was a prospect of a substantial addition to productive capacity



PANORAMA OF JOHANNESBURG IN 1895. THE POSITION OF SOME OF THE PRINCIPAL MINES IS INDICATED BY THE NAMES ABOVE.

by opening new ground and adding to the mill plant, progress has not been what it might. On the other hand, the Government has not profited as it should. The indirect taxation through the medium of authorized monopolies has brought to the State exchequer but a small part of the total imposts, the remainder going to the favored corporations. But more important still, the Government income has been largely diverted from needed internal improvements to disproportionate armament, which would have been wholly unnecessary had not the Government unwisely provoked the resentment of the Uitlanders, whose efforts to effect a change in their favor became a menace from within and also involved outside intervention from the Power whose subjects were most nearly affected.

A GROUP OF KAFFIRS—THE ABORIGINES AND PRESENT NATIVE LABOR OF SOUTH AFRICA.

A superficial view satisfies many. On the surface the Boer argument seems conclusive. It has often been expressed in varying phrase, and may be thus summarized: The Boer says in effect to the Uitlander, "This is our country; we settled it. These mines are in our territory, subject to our regulation. If you don't like our customs and our laws, why do you come here or why don't you get out? At all events your properties have flourished. Further, as to this franchise controversy, we do not believe you mean to become real Afrikanders; you only want to run things to suit yourselves."

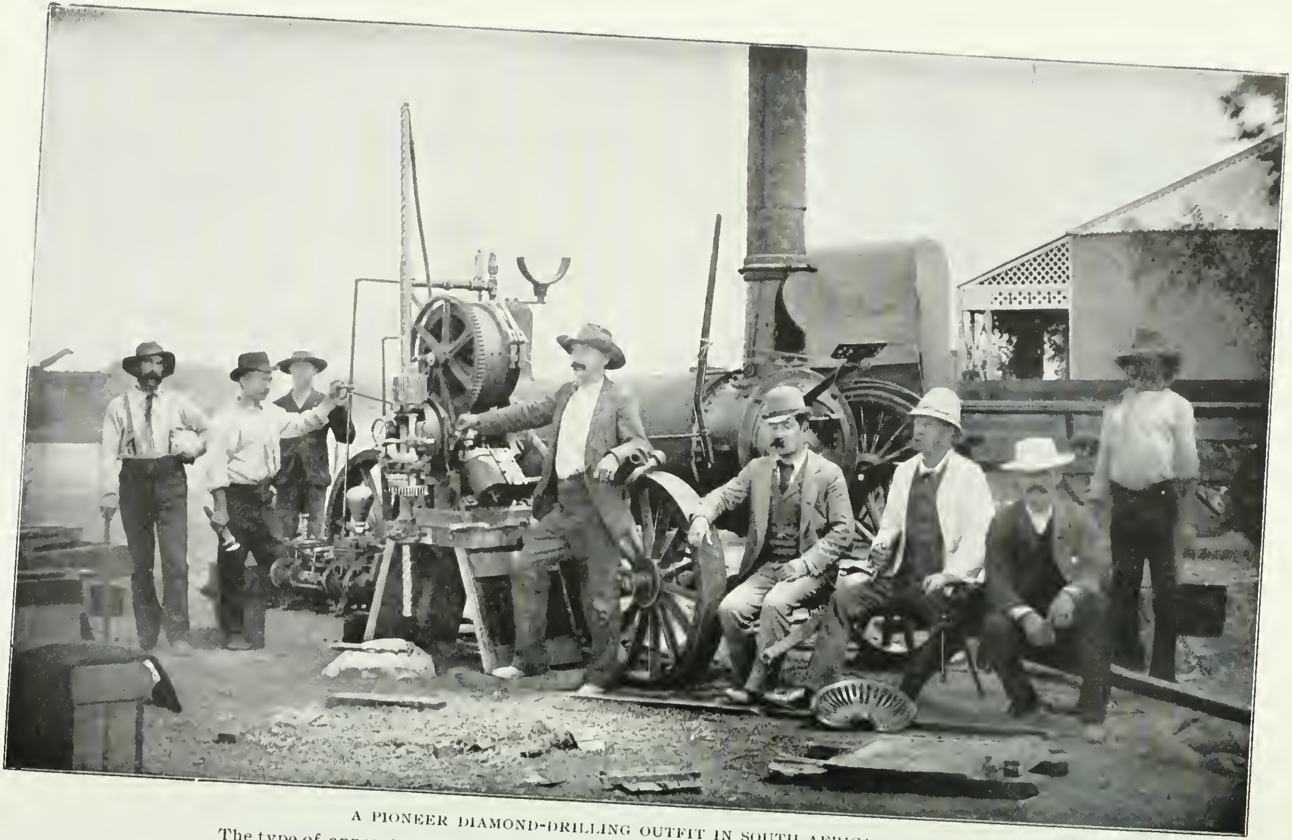
PAUL KRÜGER.

Of course it would be casuistry to deny the first proposition; for to assert that the land belonged to the Kaffirs would be about the same thing as to say that the United States, Canada, the whole New World and all colonized or conquered countries are held under no valid title but belong to the aborigines. Nor, unless modern ideas are at fault, will it do to assume the "Know Nothing" doctrine to be right, and to defend the alternative oppression or exclusion of aliens. No country rightly claiming to be civilized now maintains a system like that of the Boers. As to mining, the laws of different countries vary, but their aim is more or less liberal, not repressive, the restriction being such only as to ensure orderly regulation and the definition of titles, the usually light imposts being incidental rather than for the extortion of revenue. But in the Transvaal this one industry has had to bear nearly the entire burden of taxation, directly or indirectly. Furthermore, while it is true that the Boers were the original white settlers, the development of their country, except in the crudest form, has been due to Uitlander enterprise and intelligence. It is the mining and all the other industries necessary to and dependent upon mining, which have converted a once uninviting land into a highly prosperous one. Would the Boers have found, opened and developed the mines and established all the other now productive avocations? Once their land barely sustained them and its imports were insignificant. Now it is, except for war, most flourishing, with the promise of indefinite advancement. With material progress the opportunity arises for education, culture, and broadening of ideas. Isolated and stationary, the country's outlook would have been far different. Surely all this imposes obligations.

A HAMMER BOY IN THE STOPE.
Simmer & Jack Mine, Johannesburg.

The Orange Free State had no very direct interest in recent controversies. Its relations with Great Britain, outwardly at least, were amicable and might so have continued. But the fear of the Free State burghers that their country would follow the Transvaal, if the latter were absorbed, led them to join hands with their neighbors.

A REPRESENTATIVE SHIFT AT A SOUTH AFRICAN MINE EMPLOYING ABOUT 5,000 NATIVES.



A PIONEER DIAMOND-DRILLING OUTFIT IN SOUTH AFRICA.
The type of apparatus which has reduced the exploitation of ore deposits to a certainty.

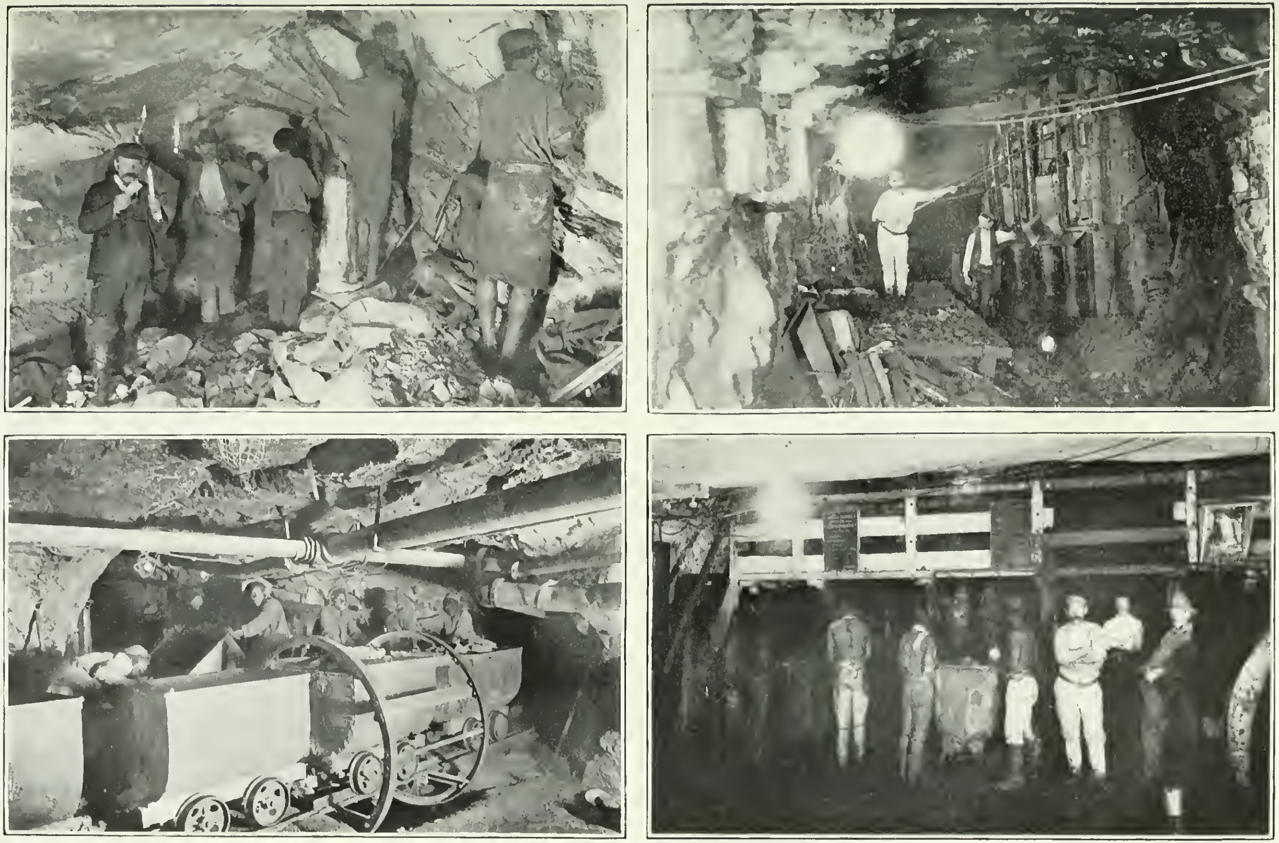
KIMBERLEY DIAMOND MINE, 1899.
An investigating party going down into the old workings

The "black danger" is always an unknown quantity, but the native races have not favored the Boers, against whom they have many an ancient grudge. Thus far they have been apparently quiet.

Before considering the interests of the great world, it may be well to refer to the position of the Americans now or lately occupied in the disturbed territory. As is well known, the engineers and metallurgists who have done so much to develop South Africa are in large number Americans. Most of them were employed in executive or consulting capacities. Very few are owners of property; they were for the most part working on salaries. With the closing of the mines these men, who would be neutral on purely political questions, are sufferers. Their interests fall in with those of the other Outlanders, and naturally, also, with those of the English capitalists, their employers and associates. Yet, notwithstanding any bias arising from personal interest, and making all allowance for human fallability, it is well to note that their opinion is concurrent and decidedly against Boer methods. Men of this stamp, who can always find profitable occupation at home or elsewhere, are entitled to credit. It will not do to denounce their opinions as those of mere sordid speculators and adventurers. What these opinions are is well known. Perhaps if they had not come into personal contact with the Boer system, and had had no direct experience and no opportunity for observation, they, too, might join with the unthinking at home. They have found it less easy to sympathize with the Boer at close quarters than at a distance.

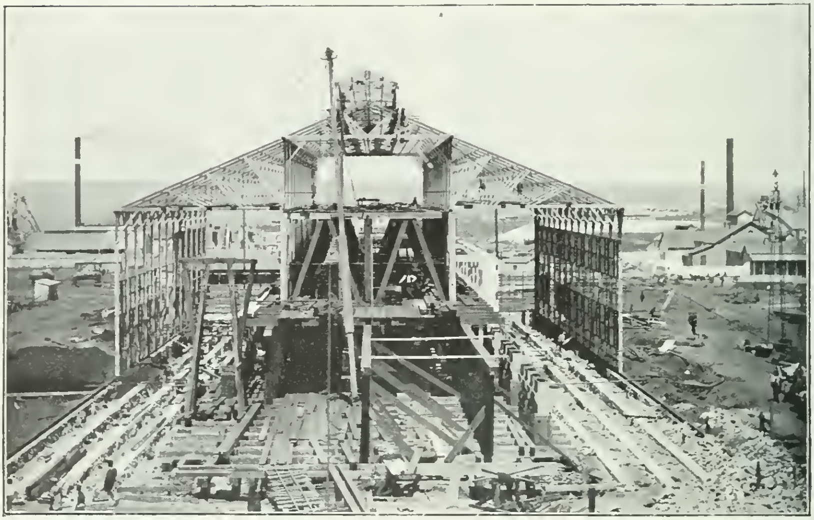
A REPRESENTATIVE SOUTH AFRICAN MINE. THE ROBINSON.

Passing now from a consideration of single nations or groups of nations it is pertinent to inquire what is the material interest of the world as a whole in this South African question. Evidently, as a dictum of common sense in economics, it is for the interest of all to develop to the utmost the resources of a part. In this case these resources, so far as now known, consist, first, in the gold mines of the



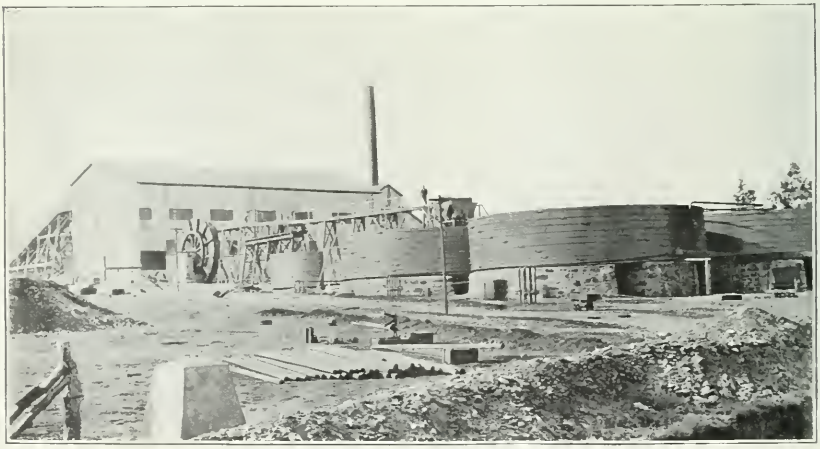
UNDERGROUND IN THE SOUTH AFRICAN MINES.

The two views on the left are in the Simmer & Jack proprietary mines; the two on the right are in the 1,000-foot level, Kimberley.



A TYPICAL STAMP MILL IN COURSE OF ERECTION ON THE RAND.
This battery is at the Simmer & Jack mines, and is the largest in the world, containing 280 stamps.

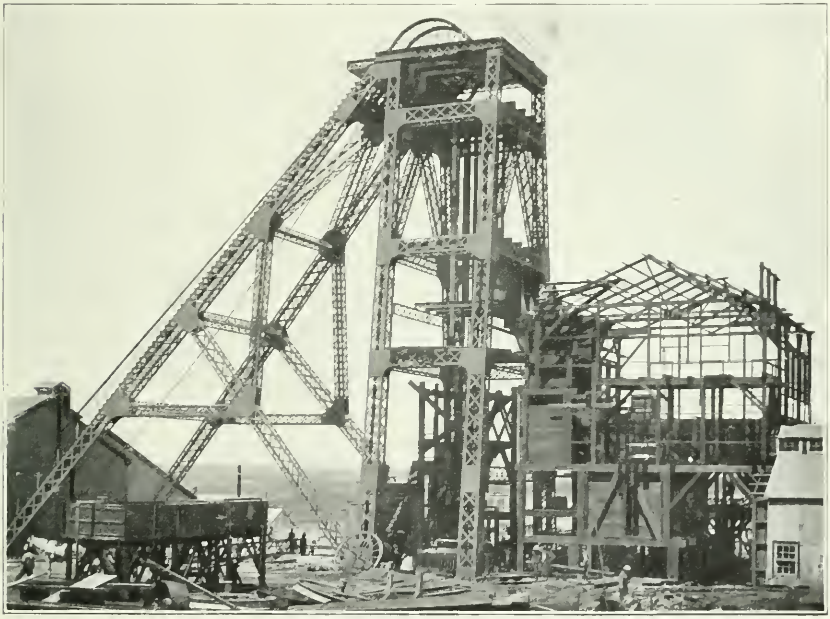
Transvaal, and, in less degree, in the gold mines of contiguous territories. Next in permanent importance perhaps might be ranked the coal deposits, originally opened to assist in gold getting, but later worked for supplying railway and steamship fuel and for general purposes, and promising to add largely to the welfare and advancement of a vast area, where timber is scarce. Northern Natal has been prominent in coal production, but the workable beds are widespread. The



AN AFRICAN CYANIDE PLANT. THE WOLHUTER WORKS.

diamond mines, so important commercially, so profitable and so fascinating to prospectors and investors, must not be forgotten, for their future is also at stake, though apart from the central dispute. Then there are the railways, telegraph and telephone lines, power and lighting plants, and all the purveyors of supplies to the mines and miners. In the aggregate the present investment and "turnover" of all these allied industries is immense; but their future importance will be far greater. In their exploitation, the whole world has a stake. Whatever hinders or weakens this advancement is a positive loss to civilization.

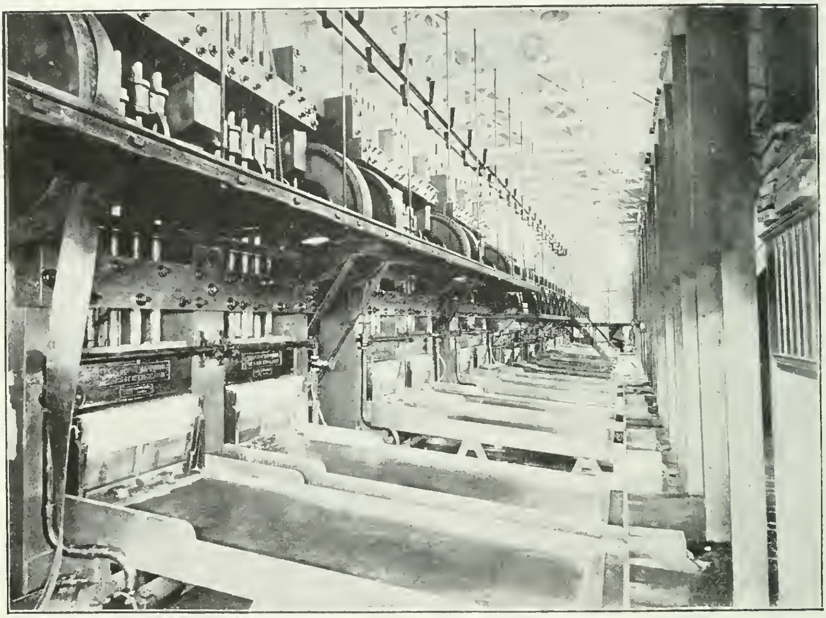
The gold mines of the Rand alone had produced some 19,000,000 ounces up to the outbreak of the war. However they may be retarded for the time being, their future is assured. Even if surface plant should be destroyed and workings flooded or filled in, the ground will still be there. Estimates of the total gold still remaining and available are necessarily not very reliable, but conservative engineers have placed the figure at about £600,000,000 ($3,000,000,000). All gold deposits vary in size and in richness at different points. The most regular are more or less spotted with zones or patches and chutes of pay ore and with spaces of barren ground or of ore of grade too low to be workable. In the case of the Rand reefs, however, there is a nearer



HEADWORKS OF A RAND MINE.

Steel headgear at No. 2 shaft, Robinson Deep.

approach to regularity than is often found in districts of minor importance—certainly nearer than in any gold region of large area and consequence. The conglomerate beds are about as uniform in thickness as most other stratified deposits, and they are very persistent. From the main outcrop the beds dip at first steeply, but in depth the dip flattens somewhat and is expected to carry the beds to a not inaccessible depth over a very large area. The lines of "deep-level" shafts and prospecting boreholes furnish evidence of this. The whole series of rocks form a wide syncline, the outcrops being on one edge. There are faults in places, but these are becoming better understood as workings advance. The syncline may be basin shaped or an oval depression, or it may turn out to have a longer axis than known at present. The depth to which mining may be prosecuted on the Rand is very great, as the temperature-increase is slight and water gives less trouble than in most mining districts. Under such favorable conditions it is possible to go down perhaps to 10,000 feet vertically from the surface. A few years ago it was thought that 6,000 feet would be the limit, but the deep shafts of the Lake Superior copper mines have proved that the mechanical limit is much farther down. Vertical electric railways, or cable hoisting in relays, with electric-power transmission to the lower hoists, will obviate the former disadvantage of the



A STAMP MILL ON THE RAND

great weight of long cables as compared with live load, and the danger of such cables breaking from their own weight. Similarly, pumping can be done from an indefinite depth by electric power. The question of very deep mining hinges rather upon the financial than upon the engineering question. The cost of the heavy plant to operate a deep shaft is very heavy; so also is that of sinking the shaft; and that of operating the mine when the ore is reached is of course greater than in shallower workings. Another item is the loss of time during the preliminary dead work of sinking, etc., which means the locking up of large capital and the loss of interest. But if ore of satisfactory grade and quantity is at the bottom, investors will be willing to advance all the money needed and to wait patiently for returns. Many mining enterprises have been successfully carried out which required very heavy investments and two years, or much more, of preliminary work. It all depends upon the ore and the assurance that it is there. Underground prospecting is becoming so reliable, as compared with former guesswork methods, that it is now often possible to plan very large mining enterprises with reasonable security and accuracy.

Dr. Hatch has gone over the subject of present mining expense on the Rand very thoroughly (in this Magazine for last August). It may be remarked, briefly, that in any event these costs will be considerably reduced in the future. Under British rule the dynamite and railway monopolies would be suppressed, and thus two heavy items would be largely cut down. Labor expenses cannot, perhaps, be much

DEPOSITING FLOOR, DE BEERS DIAMOND MINES.

lowered, except by the introduction of a little more machinery, since it would be hard to reduce wages. Timber of good quality will always be scarce; some of the best has been shipped all the way from Oregon to African ports, thence over the long and costly railway haul to the mines. But, relatively speaking, the mines do not require very much timber. Altogether, and taking the removal of a large part of the taxation into the account, it will be seen that a large margin of reduction in mining costs may be looked for if the district comes under a liberal government, or if the Boers make concessions. The crushing and cyaniding costs have already been brought to a wonderfully close figure, considering the conditions. In fine, a tenor of much less than 5 dwt. per ton will some day pay, if the ore is in sufficient quantity.

THE KIMBERLEY DIAMOND MINES IN 1874. SHOWING THE ROPEWAYS.

The total life of the Rand mines will depend, of course, upon a number of conditions—especially upon the rapidity of exploitation—and various estimates have been prepared. What can reasonably be calculated on, from fairly reliable data, is a duration sufficient to warrant as permanent investment as is prudent in any mining undertakings. Besides the series of Rand reefs there are many other known gold-bearing deposits in South Africa, both within Boer territory and in British ground. Some of these are already producing large amounts, and others are promising. So far, nothing to equal the central group of the Rand mines has been found; but there are indefinite possibilities. As so much of the country is gently-rolling, covered with the heavy overburden of the veldt, there may be an indefinite number of blind ledges yet to be uncovered. The area is so vast, however, that outcrops in more rugged and bare localities escape observation by the few prospectors. Placers are more easily found, and have been worked on a moderate scale for some time.

It is evident that there will be room for a large extension of gold mining after existing troubles are over. The country does not hold out very alluring inducements to the poor settler, and unskilled white labor is at a great disadvantage in competition with the cheap Kaffir labor. But for judicious investment there will be great opportunities, which will be grasped by capitalists who are dissatisfied with the low interest and low returns from manufactures, transportation enterprises, etc., in older countries.

THE KIMBERLEY DIAMOND MINES IN 1899. THE WORKINGS ARE NOW UNDERGROUND ONLY.

Another point suggests itself. So long as gold is the recognized standard of values by the leading commercial nations, the supply of the metal becomes of great monetary importance. The assurance of a regular and large output from the most important gold-mining district known will remove fears of a shortage of coin money. The coming supply, though surely large, does not, however, threaten to unsettle values by overproduction, which was feared in the early days of the Californian and Australian gold excitements.

Diamond mining stands somewhat by itself, but has been handicapped in somewhat the same manner as gold mining, if in less degree. The industry is a most important one and has been very productive, with a long future still before it. A reduction in cost of transportation, supplies, and general charges will cut down mining expenses, though there may not be the same margin as in the case of the gold mines.

The same remark applies to coal mining. This industry has an assured future, apart from the market for the product at the other mines. The high transportation charges have affected coal mining, both as to supplies and as to the marketing of the product, and there are other items which will admit of betterment. The coal mines in British territory, of course, were free from certain exactions which would have been placed on them if under Boer laws, but there is room for improved conditions.

The number of persons who have a direct and tangible stake in the fortunes of South Africa is increasing, and their interest is most keen. All the world is watching with eager attention the march of events, military and political, in that far-distant theater of action; but all the world does not realize how serious is its less obvious indirect interest in the welfare of the territory in question. It is, perhaps unknowingly, witnessing the working out of one of the most impressive evolutionary changes in economics as well as in politics.

For illustrations accompanying this paper we are indebted to the courtesy of the Rand Drill Co., the Gates Iron Works, the Ingersoll-Sergeant Drill Co., the M. C. Bullock Mfg. Co., Messrs. Fraser & Chalmers and Mr. Geo. H. Sampson.

THE VAAL RIVER AT BARCLAY WEST.

STRENGTH AND WEAKNESS OF THE TRUST IDEA.*

By John Graham Brooks.

"The first object ought to be to insure, so far as practicable, that the public should be afforded all such information as would affect the reasonable judgment of a man in determining whether he would or would not invest in a particular concern; and the next object ought to be that all holding fiduciary or quasi-fiduciary positions should be bound to disclose fully and clearly any interest which they possess differing from the interests of the other shareholders—in other words, that the transactions should be open and above board, and all the parties dealing on equal terms."—*Lord Chief Justice Russell, commenting upon the Hooley disclosures.*

IT may seem fantastic to quote Emerson on the subject of commercial changes but, as Tyndall found many a scientific hint in the pages of this seer, so we may find in him many an illuminating comment on industrial events. Note for example this: "Wealth is the application of mind to nature; and the art of getting rich consists not in industry, much less in saving, but in a better order, in timeliness, in being at the right spot."

I do not know in economic literature a truer word upon the significance and the necessity of business organization than these words contain. "Better order," "timeliness," "being at the right spot." Here is the very heart of the new organization if we consider it apart from its abuses. It is not merely to the new importance of location and organization, as commonly understood, that Emerson calls attention, but even more to the mental processes that gain in value at every stage in industrial evolution. This penetrating observation helps us to realize the relation between organizing thought and the external machine which thinking creates. The locomotive was a mere record of the inventor's mind, but to organize the railroad system of the United States requires the same kind of thinking, only upon a much higher plane. Every event that has widened the world's market has made a new machinery of organization vitally necessary. The organization of the Sugar Trust is an invention in the same sense that the new machinery for refining is an invention. When competition has reached a certain desperate pitch among separate businesses within the same industry, a new task for the inventor has become a necessity. No analogy is probably so fit as that of the railroad. Here is our greatest and most powerful machine. All now admit that a perfectly free competition among these competing roads resulted in disaster; disaster to the stockholders and, in the long run, disaster to the public. When that period was reached, no remedy was possible except that which the inventor could command. To organize the conflicting roads into some harmony of action was an invention as strictly as any that the Patent Office holds. I have heard it said by a railroad president of large experience: "The next great step is one purely of organization. Our difficulty is to find the ability equal to the task." The ability, when it comes, will be, however, the ability of the inventor and the reorganization desired will be accurately analogous to the cunning which thinks out any lesser mechanism. The old machine merely put separate tools together into new relations. But it is still mechanism and invention to organize separate businesses to meet the conditions which a world market imposes. In this larger market the isolated business has become (in the instances we are now considering) like the separate tool. Where competition has brought confusion, the separate agencies have now to be united. This is the work of the new organizations. But the question must be faced: Has competition reached this frantic pass? Of course it has not reached it over anything like the whole industrial field. It appears to have been reached in some industries—like soft-coal production—where neither knowledge nor the proper agencies for organization are under our control. That it has been reached in other specific fields, where trusts are now appearing, is susceptible of the most convincing proof.

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* To persist in the use of the word "trust," long after it has lost its original meaning, may seem to be without excuse, yet the new terminology for the larger corporations that have come to the front is so ill-defined and so cumbersome that it seems better to retain the word.

The evidence upon this point has an importance so great and so immediate that it should be given in specific form and be taken from those who speak from experience and with the least possible bias. First-rate men of business should, therefore, tell their own story. The discussion of the Trust is now developed so far, that the general ground of advantages and disadvantages cannot be covered in a short article. I therefore select, for chief emphasis, the state of competition in certain parts of industry which makes it impossible any longer to do business wisely and profitably through small and unrelated concerns. From a vast amount of proof, I take the following instances:

So competent an authority as Mr. F. B. Thurber said before the Industrial Commission about the grocers: "Competition in the distribution of sugar became some time ago so intense in the grocery trade that the dealers were distributing it, not only without profit, but for less than the actual cost of doing the work. So the grocers got together—they have always been more or less associated—and asked the American Sugar Refining Company to assist them in securing a fair reward for the work they were doing. It was pointed out that it would be to the interest of the company to have the trade in a solvent, rather than an insolvent, condition and they were asked to make an arrangement, fixing the price at which the grocers should sell, and providing for a commission or rebate to them for doing the business. They hung off for a year or more, and it was only when the margin of profit was absolutely wiped out that the grocers, by keeping after them, finally succeeded in securing such an arrangement. Immediately some of the newspapers came out with the charge that there had been a great grocers' trust formed in the interest of the American Sugar Refining Company; whereas, the truth is, the grocers had had the hardest possible job to talk them into making the 'factor system,' as it is called. Even now it costs the average grocer, I think, about 4½ per cent. to do business, and he does not get more than about 4 per cent. in the distribution of sugar."

From some careful study of the soft-coal industry in the United States, I believe it within the mark to say that its condition, as respects free competition, is even worse. We have been deceived by the fine talk about "perfect organization" because this perfection applied to the separate individual concerns. But perfect organization in a separate mill, factory, or mine does not in the least meet the exigencies of a widening market that are now forced upon the trade. The general chaos that free competition had brought upon industries that are here considered cannot be seen if the eye is directed chiefly to the single business, but only as we look at the whole group of firms or corporations, and note *the relation in which they stand to each other.* The manner in which they have come to fight each other—the wasteful and sorry devices to which they are driven—give us the only true measure to the facts.

Socialist writers who have merely railed at competition, while they have often stated the fact, have not given us the most telling details. I have heard one of the most successful business men in the eastern States say, "If people generally knew how stupidly and wastefully much of the large business is carried on, we business men should become objects of ridicule." The able chairman of the Interstate Commerce Commission has recently characterized American railroad management in the following terms:

"I undertake to say that if the worst enemy of the railroads whom you can name were elected President of the United States, and if he should pack the Interstate Commerce Commission with the worst Populists of the land, those men would never dare to do the reckless and indecent things which the managers of railroads themselves have done. Can you name any five men so ignorant, so prejudiced, so inimical to the common interests of the country that they would upset the commerce of the country and demoralize rates and business in the way the railroad men have done by putting in force the rates that now prevail to the seaboard by way of Galveston and Missouri River? Would they let the Missouri River rate be as low as the Chicago rate? Would they allow flour to be carried from Minneapolis to the Atlantic cheaper than from Chicago? In such things the railroads are making a fearful misuse of their power." This puts no slander upon the intelligence of the managers. It shows rather the pass to which an unregulated competition has brought things in this great industry.

What boasting there has been about the marvels of organization in insurance! Yet I have heard from one of the foremost men in that business this criticism: "It would not be safe to have it known how badly and how extravagantly things are managed over the whole competing field." I asked a very prominent insurance man of the middle western States if this were a fair statement, and he replied: "I should state it, if I could, in much more vigorous English. Competition has got us now where the only dress that we ought to wear is the cap and the bells." Even if it be maintained that there is some exaggeration in these strictures, the main fact cannot be contested.

Now it is only upon this background that the need of the new organization of business can be fitly studied. No argument appears to weigh more with thoughtful men, who fear these combinations, than that "they will destroy the independence of thousands of small business men." The slightest study in detail of the areas we are considering shows that competition was already raising havoc with this same class. What does the "proud independence" of a small owner of a soft-coal mine signify? What did "independence" mean for the corresponding man in the hard-coal industry before it was brought under a powerful combination? Wherever competition has developed into such excess, as in the above industries, it is grotesque to talk about "independence of the small middle class."

So far then as the business men above quoted have told us the truth, I submit that the time is already at hand for some kind of wide, effective, and thorough re-organization. Nor do I believe it open to doubt that the immense pressure of this necessity is producing the so-called Trust. Men will fight it as they fought machinery and with precisely the same results. At least fifteen years of hostile legislation should have made it clear to the dullest man that the greater massing and ordering of capital cannot be stopped. It may be annoyed. It may be forced to change its methods or place of business, but what is essential to the new process has not been checked in the least. The reason for this is that forces far more powerful than legislative action are behind this movement. In many trades it is at least possible to overstock the market in seven or eight months of work at full speed. This fact is revolutionary in its significance. It means that the time has come for conscious and calculated adaptation of the product to the market. Now the small business is helpless to make any such adaptation. A powerful combination can do it, so far as to steady every process both for capital and for labor. Every attempt to check this new necessity is as idle as it is obtuse.

Texas and Missouri may exclude trusts, but with what results? The products will be produced elsewhere and the goods be taken back to be sold in those States by agents. When the working people of those States find this out, are they likely to take kindly to this exclusion of work from their midst? Not unless they differ from the workingmen elsewhere. The most intelligent and powerfully organized unions, as among the iron and steel workers, already show the most positive signs of welcoming the Trust as likely to give them a larger and surer opportunity of identifying their group interests with the interests of the industry. Only those who represented the decaying order of the Knights of Labor at the Chicago Conference* showed the slightest hostility to the new combinations. Men who stood in the closest relation to iron and steel unions reported their members as more and more convinced that the industrial reorganization marked a favorable epoch for organized labor. "Many of our men are already taking the preferred stock in the new combines," said the former president of the Iron and Steel Workers. This declared purpose of many of the strongest unions to favor the Trust springs from the belief that it will be easier to cope with a highly centralized power than with scattered employers. Many a strike has been checkmated by the aid, (as by filling orders), which other employers have given to the one whose men were out. It is now claimed by the unions that they can act as a unit against a single organization. Their long experience of the importance of having public opinion upon their side also accounts for much of this approval of trusts. They feel with much justification that, when the issues come fairly before the people, public opinion will not allow all the advantages of organization to go to the men at the top. It will seem but fair to insist that the entire group within the industry—employers and laborers alike—have the same privileges that organization gives. Another result sure to follow is the pressure which the larger organization is certain to put upon the trade union. Its constant weakness has been the lack of cautious and able leadership. It is already seen that the Trust brings the ablest men in the industry to the front as managers. The same is likely in the long run to prove true of the unions.

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* The National Trust Conference held at Chicago during October is here referred to.

It is, of course, true that the present is no time for final judgments upon any of these questions. The high tide of prosperity that now favors the United States can float the craziest crafts. Only at the ebb will the test come. Even if the shallows are strewn with wrecks it will not prove that the Trust is at an end. It will only repeat what American railroads have to a large extent already passed through. Beyond and deeper than all these failures, crazy schemes, and wildest gambling, are the uses and the necessity of an ever wider and more thorough organization. For many of the great industries the same need of regrouping is at hand, and the one test of intelligence is to distinguish clearly between the uses of the new order, that we cannot longer forego, and the abuses that shadow every step of civilization; abuses that must be fought as abuses, and not as inherent or structurally necessary to the industrial transformation.

The question then presses; even if reorganization has become a necessity; even if enormous economies will result from the new order; even if production can be adapted to the market, business steadied through the year and the laborer kept more evenly at his work—what of the open and certain evils that affront not only our morals but our intelligence? I shall say little of the fear that just now seems to be most popular—"over-capitalization"—because what is most dangerous in this to the community at large may be met by publicity. Indeed, most of the evils will be found to centre in the underhand methods which no civilized nation, except the United States, any longer permits. The rank abuse of special rates by railroads is also a part of the same corrupting methods. It may be taken as a certainty that a large number of these enterprises will go to pieces. Scores of attempts are now making among industries in which the limits of free competition are by no means reached. Others are over-capitalized to such an extent that the first prolonged strain that is put upon them will bring disaster. It is to be hoped that the end will come for these more reckless ventures before the shadow of the next business decline falls upon the country. To squeeze the water from any large number of these concerns in quick succession would mean a danger of the first importance. Of tariff privileges to these combinations, inexcusable as they are, it may, I think, be confidently predicted that public opinion from every quarter will rise up against them.

Let us turn then to the foremost danger. To deal with it adequately would require far sharper distinctions between the economic and the political elements than is possible in this article.

The dominating peril of the trust—the peril that includes most others—is the influence of the large corporations upon politics and the bearing this influence has upon economic privileges. The part that certain corporations have played in corrupting the sources of political life in the United States is quite the gravest danger under which the country suffers. I have never heard so drastic a statement of this fact from the wildest Socialist, as I have heard a score of times from the very men who do these things. The new combinations add four-fold —ten-fold—to their power. What, then, shall keep them from the old tricks on a far greater scale? I put this question recently to the manager of one of the strongest combinations in the United States. His answer contains, I believe, what will prove true of those combinations that survive, let us say, the next business depression. He said: "In concerns so concentrated and so powerful as the new combinations, the old secrecy will have to go. We shall be too easy a target for a hostile public opinion. We shall be driven, in self-defence, to methods that will bear the light." No feature of this whole movement is more hopeful than that which these words imply. The immense changes which the vaster organization carries with it are almost certain to force, for the first time in American industrial life, far greater publicity of business procedure. Before dealing with this chief "remedy," it should be said that the old distinction, of which we now make so much, between public, semi-public, and private corporations is sure to be profoundly modified by trust development. Mere magnitude of industrial operations in the products of common necessity will convince the public more and more that iron, hard coal, sugar, and the like, may pass into semi-monopolistic control so widely and so delicately related to the public needs that the term "private corporation" can no longer apply to them. It has long been said, "Iron is the basis of our material civilization." Is it then to be questioned that a common necessity of life, controlled under unitary management to the extent of seven or eight hundred millions of dollars, is not, in a quite new sense, public business as well as private? Publicity is, therefore, not only the first of remedies but one that is certain to be enforced. The evils of corporate secrecy are strictly comparable to the other evils of competition, which have just been considered. When competition reaches its cut-throat stage, secrecy takes on a far more dangerous character.

One advantage of the rising agitation is that the important facts in regard to stockkholders' rights are for the first time being brought clearly before the public. Thanks to Delaware and West Virginia, where the furor to attract corporate capital has gone to greatest length, the public is certain to know both the abuses of secrecy and the present conflict between existing law and the investors' rights. These States permit stockholders' meetings to be held wherever those who control the corporation may elect to have them. The same free and irresponsible use of the books is also allowed. Authentic instances are reported in which the stockholder hunted in vain to find where the books were kept. English law gives the stockholder the right to demand whatever information concerns his interests as an associate in the corporation.*

Two able investigators of trusts† who visited the United States to make careful personal inquiry were amazed to find how little had been done legally to assure the stockholders those elemental rights which publicity affords. Dr. Von Halle says in his book: "It is one of the most disastrous holes in the corporation law of the United States that stock companies are not forbidden to buy or sell their own securities. In Europe such transactions have been punishable for many years." No one, indeed, is saying these things with more emphasis than the able men who make or manage the trusts. In his statement before the conference at Chicago, A. F. Hatch spoke thus: "Stockholders should have access to the books and records of the corporation at all reasonable times, and should have the power to compel disclosure of all information necessary for the protection of their interests. All corporations which appeal to public support by placing their stocks upon the public exchanges, thus inviting investment by the public in their securities, should give the greatest degree of publicity to their affairs. If the public are invited generally to invest in the securities of a corporation, the truthfulness of all representations made should be enforced and the same degree of publicity to which the stockholder is entitled should be extended to the public."

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* A bill now in Parliament is said to make it a penal offense to refuse the list of stockholders to anyone who may demand it.

† "Trusts or Industrial Combinations and Coalitions in the United States." By Prof. von Halle, University of Berlin, published by Macmillan. "Les Industries Monopolisées aux Etats-Unis," par Paul De Rousiers, Colin, Paris.

This secrecy is, moreover, the fertile mother of another brood of ills. Secrecy makes it possible to organize both the opportunity and the temptation to play the industrial game with loaded dice. The itching to get something for nothing upon the market is at any time the master vice in trade. One risk of the business boom is always that it lets loose these reckless forces that hasten every disaster of the next business collapse. The new "combines," if they can manipulate clandestinely, easily fire every passion to play with stock variations—to lay traps for the unwary, to declare dividends that never have been earned, and to unload lying values upon the public. The forms that this gaming trickery may take are hundred-fold. Just now a stockholder in one of the better "trusts" tells me: "We have declared a dividend on the common stock, but I would lay a wager that it has not been earned. Whether it has or not is impossible to find out." Vicious as all this is, it would be as silly to lay the fault primarily at the doors of these corporations as to curse money because people will gamble with it. Yet it is evident that every form of secret control—every hidden device, as to methods of management—immensely overstimulates this dicer's spirit and therefore adds to the most dangerous uncertainties of business. A capitalization based on what one hopes for one's business—capitalizing mere bragging and conjectures—is what secrecy makes possible. That this evil can be greatly lessened has been proved not only by English experience—it has been clearly proved by Massachusetts experience. That State has already had many years' experience in controlling over-capitalization, not only in semi-public corporations, but in strictly private ones. The degree of publicity to which these corporations must now submit in Massachusetts is far greater than is commonly supposed, and has been attended by results so hopeful as to mark a sure way for further legislation. The recent testimony of the Hon. J. J. Meyers before the Industrial Commission will prove of value to the public upon this point. This experience, together with the experience of the Interstate Commerce Commission—in spite of all its failures—may well furnish a safe basis for such Federal action as shall give unity of procedure in different States. That such action upon the part of the general government swarms with difficulties means only that industrial growth now presents for solution a new set of problems.

Finally, the present condition of a score of these combinations brings out with startling clearness one hopeful fact. Nothing is more to be feared in this movement than too rapid or too easy triumphs. Fortunately, these quick achievements are under the most wholesome check of finding an experienced ability equal to the tremendous tasks that suddenly enlarged organization imposes. Another phase of this fact is the loss, in the new grouping, of all that is meant by "good will." It will certainly require much time to offset this loss of direct personal interest, built perhaps from the beginning by the man himself, as it passes into a more impersonal and wider combination.

Between the capacity to run an average corporation and the capacity to run a corporation of five or ten times the magnitude, there is no calculable relation. Yet many of the trusts have to depend for their success on that very unknown quantity of talent. It cannot be extemporized nor made in a month or a year. It is an open secret that several trusts are at the present moment suffering keenly from this want of ability to match the exigencies of the reorganization. A group of corporations may have, among its managers, a man to match the new duties, but it requires time and repeated tests to be assured of this. It requires time to persuade other directors, who think well of themselves, to admit the superiority of another and yield to it. The masterful managers of the sugar and oil combinations came slowly and naturally to their positions; but what likelihood is there of extemporizing the new leadership for miscellaneous. quickly-formed "industrials"—whether of bicycles, leather, or woolens? I asked a man of experience why there was no combination in the print cloths. "Well," he said, "there are a dozen fat-salaried treasurers that have to be taken care of, which is difficulty enough; but a far greater is the entire uncertainty as to what one head is equal to the general direction. At least two very dangerous years would have to pass before we could find that out." This difficulty is not fatal. It will wreck many attempts, but reorganization will follow when time and conditions favor.

If the period of reorganization is upon us, the very necessity will create the strength to guide the movement. Men's wits do not greatly change from age to age, but mechanical aids to intelligence increase as by magic. The manager of one of the chief industries in Pennsylvania was asked what difference the telephone had made in his business. He replied: "If I may add the typewriter, I should say that the telephone enabled me to do at least five times as much business as formerly." The assured extension of these appliances in the future shows that time is likely to bring out the capacity equal to the new emergencies. This waiting period is, however, one of the most beneficent restraints, from every point of view.

WORKS MANAGEMENT FOR THE MAXIMUM OF PRODUCTION.

By J. Slater Lewis.

III.—COMMERCIAL ASPECT OF THE PROBLEM OF NEW PROCESSES.

IN approaching the "Problem of New Processes," care must be taken to pay due regard to practical considerations, as distinct in many ways from the theoretical and technical. I propose, therefore, in this article, to deal with a few points which, though some may appear to have little bearing upon the subject, are nevertheless of great importance to those who are studying the problem of new processes and other allied subjects.

There are, of course, limits to which mass-production, as an economic factor in the introduction of new processes, may go. It will be clear, for instance, that whilst bicycle makers, tool makers, engine builders, dynamo builders, and agricultural-implement makers may have their respective works equipped with special tools and appliances for turning out standard goods in large quantities, heavy and special machine-tool makers, ship-builders, makers of heavy rolling-mill and forging-plant, makers of rubber and cable machinery, bridge builders and such like, whose productions are few and special, and rarely, if ever, alike, cannot, for obvious reasons, follow suit. That is to say, that it would be an economic impossibility for them to equip their works with special tools for the production of large quantities. It is quite true that their works should be equipped with high-class tools suited to the general run of work in their shops. It is also true that their organisation and general facilities for handling their work should be thoroughly up-to-date. But to expect them to install specially large and costly machine tools for "handy men" to work, when perhaps hardly one of them would be employed an hour a day, would be nothing less than mechanical engineering gone mad. There is, therefore, a critical point in the successful working of every factory, where the principal or manager has to decide between making some of the parts of his machines with his own plant, and buying them from the outsider or specialist whose works are equipped for the manufacture of those parts in large quantities. Nor is it always a question of cost; it is more often a question of *time*. Take, for instance, the case of breakdowns and general repairs in connection with steamships and large factories. These often form work of the most urgent character, taken in hand by specialists who make a point of turning out, say, large crankshafts and large gear-wheels within an amazingly short space of time. But they are more frequently handed over to the general engineer, whose works happen, perhaps, to be in the immediate locality in which the breakdowns occur. In these cases competition, except in the matter of *time,* rarely enters into the question, inasmuch as prompt execution of the work to be performed is of paramount importance. It will therefore be obvious to practical men that I must draw a fundamental distinction between the general engineer, who, in a sense, is called upon to do a bit of everything—and who will always be existent, however crude his plant—and the specialist who has "lines" of his own and will not depart from them.

But it may be well, before proceeding to the further consideration of the problem, to clear the air of the theoretical and technical claptrap which it is so fashionable to hash up for the edification of mechanical engineers. That the time has arrived when every manufacturer must be in as favourable a position for turning out his goods as cheaply and as efficiently as those with whom he is brought into competition, no one will deny; in fact, it is rather a question of their "going one better" than keeping abreast; but when those whose knowledge of the subject is only born of their own imagination begin to advise old-fashioned engineers, all and sundry, to pull down their barns and build greater ones, it is about time for them to pause and ask themselves whether life would be worth living under such volcanic conditions. It seems to be quite the "correct" thing nowadays for all "cranks" and would-be engineers to denounce everything that is not carried out on the vast scale now obtaining in some directions. They would fain ignore the evolutionary principles upon which commercial progress can alone be made, and would have the whole engineering world instantly turned into a gigantic show-room, despite the fact that there is not at the present moment a single engineer in Great Britain whose works are not taxed to their utmost capacity. It would be against human nature itself to expect old-time engineers to set about reorganising the whole of their establishments whilst they are extremely pressed with work and making money, and writers who suggest such things do a great deal more harm than good. They should try to realise the fact that to attack these knotty problems successfully it would be better to take the retrogressive engineer gently by the hand instead of forcibly by the throat.

It is no digression to state here that the principal causes for this present feverish state of mind seem to be the orders that were sent to America for the Atbara bridge and the Midland Railway Company's locomotives. No regard for actual circumstances appears to have had any weight with the enthusiastic gentlemen who write so airily upon these vexed questions. It is with them a mere question of old shops and antediluvian tools and nothing else! But a few years ago, the mechanical engineers in the British Islands were suffering from a general stagnation of business; but what has happened? Why, almost without warning, a flood of trade came down upon them, and although large new works have been built, and many existing ones hurriedly and considerably extended, it has been found quite impossible to cope successfully with such an inrush of business. It is, of course, very easy to be clever after the event and to tell people that they should have been prepared to meet such a state of affairs.

Now, if we must treat the subject of maximum production upon sound business lines we must first throw aside all prejudices and then impartially investigate the why and the wherefore of things. Let us, therefore, consider one or two features wherein lie much food for reflection for those who regard foreign competition and the securing of these orders for bridges and locomotives as the death knell of British engineering, and who lay the blame almost wholly, not upon prices, nor upon an abnormal demand, but upon our defective organisations and the want of modern machine tools and works. Take the Atbara bridge first. We are told that no English bridge-builder could complete the work within the time specified. That has been regarded as a sign that British bridge-building is decaying for want of modern organisation and appliances. No mention whatever is made of the very important fact that, having due regard to the existing engagements of the English firms, prompt delivery was an utter impossibility. As the efficiency of British engineering firms has been arraigned in connection with this matter, I may be forgiven for pointing out a notable bridge-building incident which occurred in England about twenty years ago, when little regarding forced production was heard of. A large stone viaduct on the London & North Western Railway was swept away by an enormous flood. To have rebuilt the viaduct in masonry was out of the question, as every hour was of immense importance to the railway company. It was therefore decided to build an entirely new viaduct of steel. Drawings were at once prepared, the masonry piers built, the metal rolled. and the whole of the parts of the viaduct or bridge brought on to the site. erected, the lines relaid, and traffic resumed within one month of the date of the accident. Mr. Webb, the chief mechanical engineer of the railway, might well be proud of such a skillful and unexampled feat, and it is quite a question whether the builders of the Atbara bridge, with all that we hear about their special and modern plant, could have accomplished the task within the same time.

Mr. Webb, of course, had behind him a powerful organisation, and all the material and tools that were necessary for the expeditious accomplishment of the work, and I presume the builders of the Soudanese bridge were similarly situated; but whether, regarded as commercial incidents, such forced productions as these undoubtedly were would be financially successful in the open market is altogether another question, unless of course, standard designs were accepted, obviating the necessity for new drawings. Practical men are therefore entirely oblivious to what may be done, for once in a way, by turning a shop inside out and upside down. These incidents are therefore of no commercial value to us whatever.

And now for the Midland locomotives. It seems to be unknown generally that the locomotive shops in Great Britain are, from whatever point of view the subject is approached, superior to anything of the kind to be found either on the continent of Europe or in America. Many of these shops were the first to adopt special machine tools for special purposes, and they have kept well abreast of the times. Works lighted by electricity, machines and cranes driven by multiphase electric plant, electric cranes serving individual tools, separate plant for making their own iron and steel castings and forgings—in short, provided with every known device for the saving of labour and the production of high-class goods—many of these shops are models of enterprise and good management. But, why, it may be asked, did these British locomotive builders allow these Midland orders to slip through their fingers and get into the hands of Americans? For the very simple reason that they had already in hand at least two years of solid work for their old British and foreign customers, and were, and are now, refusing orders at first-class prices right and left. This is, therefore, entirely a question of sound business policy on the part of the buyers of British locomotives. It is, in fact, only fair to assume that there is a distinct preference the whole world over for British machines, otherwise the American locomotive builders, with their special plant and consequently cheaper prices, would have secured a fair share of this extraordinary run of work ahead.

Sir Benjamin Browne points out, in the very able article which he contributed in the October number of this Magazine, that the consulting engineers of Great George Street have seriously injured the locomotive trade of England by the capricious and fanciful notions which they insert in their specifications. Unfortunately this tendency is not confined to the locomotive industry. It is rapidly spreading to other industries, and it therefore becomes a physical impossibility for British engineers to standardise their goods and force production as is their wont. This unfortunate habit is of paramount importance to all British trades and is all the more serious since anything German or American will be gobbled up in the precise form in which it is offered! And if the subject of "Works Management for the Maximum of Production" is not to be stripped of its importance, and the attempts to standardise and force production to be rendered entirely ineffectual, the Westminster School will have to put their loyalty into practice, and place Britishers upon precisely the same footing as they do outsiders. Perhaps the mere fact that foreign consulting engineers, now having practices in London, are passing as many orders as they possibly can to foreign firms, may bring some of these gentlemen to their senses.

The whole of the foregoing questions have a direct and all-important bearing upon the subject of these articles. "Intensification of Output," or "Works Management for the Maximum of Production" means nothing less than a pitched battle for manufacturing supremacy. And, in order that we may rightly understand the strategic problems that we have to solve, it is a *sine qua non* that we start on a clear and equal basis, and not by dragging in side issues or trailing herrings right across the line of scent!

When we speak, therefore, of "Maximum Production," we mean the production of articles or commodities of given standards or excellence, at the lowest cost and yielding, of course, the highest profits. Unfortunately many large concerns, which believe in the gospel of standardisation and lay themselves out for producing lines of goods at mininmum rates, consider it to be a good business investment to sell them at ruinous prices until the little maker of similar goods has been crushed out of existence. Birmingham was the first city to immortalise itself by resorting to practices of that kind, and many a poor manufacturer remembers it to his cost. That sort of thing is now becoming quite fashionable, and if it goes on it will soon be *not* "the battle of the tools" but "the battle of the dollars." And if the dollars of one or two large firms are too few to warrant an attack of that kind upon the weaker fraternity, the "combine" comes to the rescue and by an organised effort it soon does the trick. We have seen great "combines" formed in England recently in connection with the cotton industries and other trades, also in connection with the salt and chemical trades, and others are looming in the distance. These "combines" are not, however, always successful—the salt and chemical combines" to wit. Unfortunately for them, they had to contend with independent enterprises which being so rich—rich beyond the dreams of avarice almost—were in a position to withstand organised attacks, and once having weathered the storm, a steady golden harvest for them was inevitable. The profits of these independent concerns per unit of capital invested are to-day very high, whereas the profits of the salt and chemical "combines" are, on a similar line of reasoning, a minus quantity—due no doubt to the heavy cost of flotation, the fancy prices paid for rotten concerns, the heavy organisation expenses, and last, but not least, to the want of the more *distinct personal element of control* in the management of works that are scattered about in all parts of the country, instead of being, as they are in the other case, practically in one active and convenient centre.

It will be seen, therefore, that however formidable these "combines" may be, they may not always succeed in bringing all interested parties into line—and that those who can afford to stand aside and wait events may, owing to the fillip given to prices by the "combines," find themselves in a sort of manufacturing paradise, and be safe against further attack. "Combines" are, therefore, risky undertakings to invest in, and can only be regarded as absolutely invulnerable when they own or control the whole of the raw materials indispensable to the commodities for the sale of which they were established.*

It does not require a very extensive stretch of the imagination to enable one to see that there are no impregnable rocks upon which engineers may take their stand. The exigencies of competitive warfare are such that the specialist—he who carries all his eggs in one basket—may almost at any moment find the ground cut completely from under his feet. Necessity has always been the mother of invention. As soon as one specialist begins to reap the fruits of his enterprise, another comes along either with a better article at the same price, or with improved machinery that will enable him either to wipe out his antagonists or to compel them to run their businesses at a loss. The tortuous undercurrents in the sea of competition for standard commodities are, indeed, perplexing. Small wonder, therefore, that many capitalists should regard the single and narrow channels of specialised trades as questionable outlets for investment; in fact therein lies the principal security of the thoroughly well-established specialist, whose profits are not of such proportions as to excite the competitive spirit in others. I am, of course, excluding monopolies in the consideration of these questions—concerns whose manufactures are protected by patent rights. Mass production in the case of such monopolies is simple enough, though it frequently happens that the true element of enterprise is wanting in those instances where its free and full exercise might be applied with considerable and certain success. It is, nevertheless, well known that English patent laws, with all their uncertainties and intricacies, have a baneful and injurious effect upon trade, especially in connection with the operations of those manufacturers whose means are of slender proportions and who do not care to face the ordeal of law-suits which might land them in costs that would mean the entire wrecking of their businesses. Instances of the gross abuse of the British patent laws are more numerous than a healthy condition of affairs would permit. I know of "inventions" which have been rejected by the examining officials in the American and German patent offices which are nevertheless being "run" in Great Britain by wealthy corporations under the shelter of British patents. Monopolies are often set up in that way and maintained as the result of our inefficient and ineffective patent laws which not only have a detrimental effect upon mass production as it affects the manufacturers, but as it affects the general community. Chambers of commerce and other interested institutions would in consequence find solid and profitable employment in taking such steps as may be necessary to make British patent laws directly effective by affording inventors the advantage of searches that would put the stamp of genuineness upon their certificates of acceptance and thus prevent wealthy companies having exclusive privilege under what are in reality sham patents.

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* It is highly interesting, in this connection, to compare Mr. Brooks' discussion of the Trust (pp. 351-360) and the editorial on page 431 of this issue.

Without due regard to all these contingencies "Works Management for the Maximum of Production" would be nothing less than a delusion. People do not embark capital in trade for the mere fun of the thing, nor will owners of existing shops put all their old plant on the scrap heap, and replace it by new, unless there are very cogent financial reasons for doing so. In other words, engineers will not spend large sums of money in specialising, and thus relinquish much of their regular trade, unless they see good prospects of steady markets at prices that will in the end make the general financial result more satisfactory than it was previously. Shrewd men of business care little or nothing for the ravings of enthusiasts. They prefer to take a general survey of things that are within their own knowledge, and if they have travelled and kept their eyes and ears open they will be in a position to gauge fairly accurately the probabilities of new enterprises as well as the benefits to be derived from the introduction of new processes of manufacture. Let me relate a case in point. A few years ago, an English firm in the iron trade—one of high repute and old standing—was gradually dying of that infirmity which is characteristic of old age. The new processes and smart methods of its rivals had almost killed it, when the son of the principal suggested that he should see what was being done in other countries. The suggestion was ridiculed at first, but in the end it was carried out, and it so thoroughly opened the eyes and sharpened the wits of the young fellow—himself a well-educated and capable man—that an immediate change in the firm's methods of manufacture was decided upon, and duly effected. The business gave prompt results of the most satisfactory character, and the firm is to-day again one of the wealthiest and most enterprising concerns in Great Britain. I know of other cases where "new blood," guided by an intelligent comprehension of facts and stimulated by a healthy desire to excel in enterprise, has wrought changes truly glaring in importance.

It must not be assumed from these criticisms that I am taking the part of a special pleader to the British engineer. I have merely considered a few of the side issues as essential elements in the solving of the commercial problem of new processes. I may, in fact, say right here that Britishers would be blind to their own interests if they were to ignore the excellent teachings and splendid business qualities of their Continental and Transatlantic friends. It would be highly imprudent and impolitic—nay, suicidal—for them to disregard "the writing on the wall." Whether we like it or not, and whether the ultimate end of all this specialisation and mass production be socialistic in tendency, or may lead to the death of the small man and the rearing up of the hoary head of capitalism or otherwise, the trend of the times is distinctly in the direction of a vigorous and determined struggle in which the men who are possessed of wide practical experience and implements of superior calibre will win.

In the next article, I shall first deal with the problems connected with Trades Unions and the guaranteeing of standard rates of wages, and with other subjects where circumstances in connection with these questions differentiate to an exceedingly important extent. I shall then conclude by a reference to the theoretical and technical questions underlying the subject of mass production.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

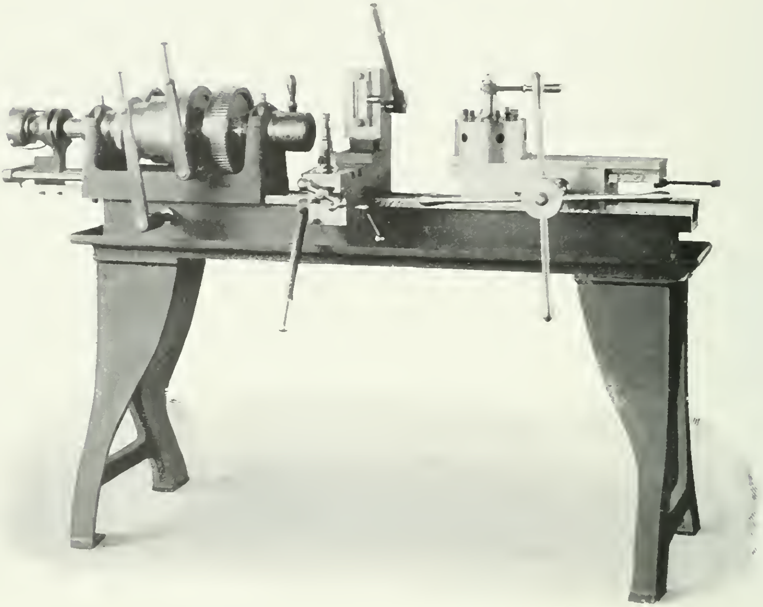
III.—APPLICATION OF THE TURRET TO GENERAL MACHINE-SHOP WORK.

WHILE the great reductions in time-cost of machine-part production, gained by the use of the turret carrying a number of fixed tools, were almost instantly recognized by manufacturers who produced large quantities of small parts in duplicate, and great numbers of turret lathes were placed in work as rapidly as they could be produced, it was long supposed that these tools had no field in the general machine shop, and that no advantage of their great time-saving possibilities could ever be taken in the construction of anything larger than small arms and sewing-machines, except in the case of valve work.

Among the early productions of the Windsor shops was a brass-working "Monitor" lathe in several large sizes, designed by Stone, specially adapted to finishing the bodies as well as the smaller parts of brass globe-valves in all common stock sizes. These machines had a production capacity from six to ten times that of the slide-rest brass-worker's lathes previously employed in valve finishing, and came into exclusive American use for valve working almost as soon as they were offered for sale.

Some of these early "Monitors," named after Ericsson's famous revolving-turret gun-boat, could handle work 12 ins. or more in diameter, either in brass or gray iron, and it seems strange that the great gains in large-valve making effected by the use of fixed tools carried by the turret should not have immediately forced the turret into general machine-shop use. Such was not the case, however; although the use of the monitor in valve making was firmly established as early as 1862 or 1863, the use of heavy turret lathes in the machine shop can hardly yet be said to be common, and did not begin to be anything like well established before 1890.

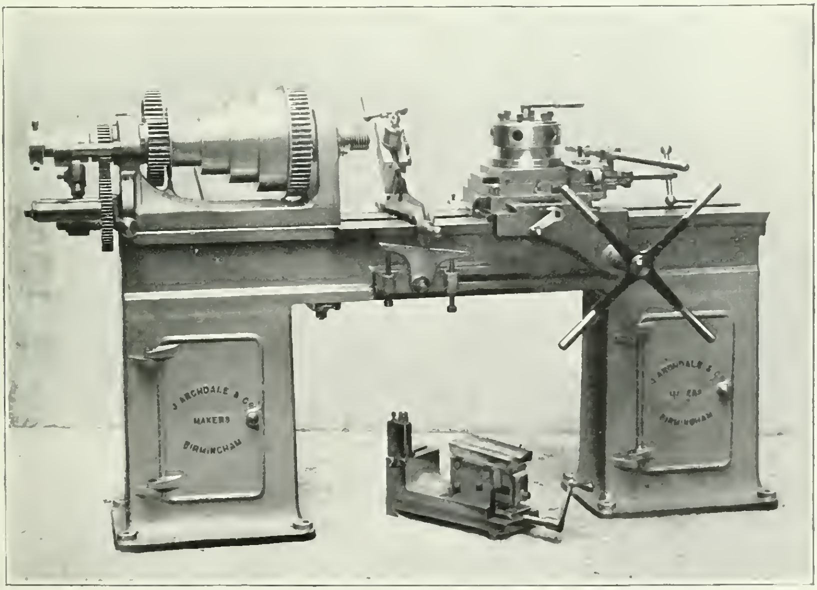
First of all, machine-shop managers, even in America, are extremely conservative and slow to adopt new methods which involve radical departures from old and well-tried means and methods. In the next place, the use of turret machines with fixed cutting edges



13-INCH FORMING MONITOR LATHE.
Has friction back gears and auto-chuck. Made by Windsor Machine Co.

seemed to demand a great number of repetitions to render this procedure profitable, and while it sometimes occurred in machine shops as managed up to, say, 1885, that numbers of duplications within turret-machine sizes were required, the cost of installing new and high-priced tools, and equipping those costly creations with the necessary expensive outfit of special tools to make them available for producing the duplicate parts required, made managers hesitate to make the formidable venture.

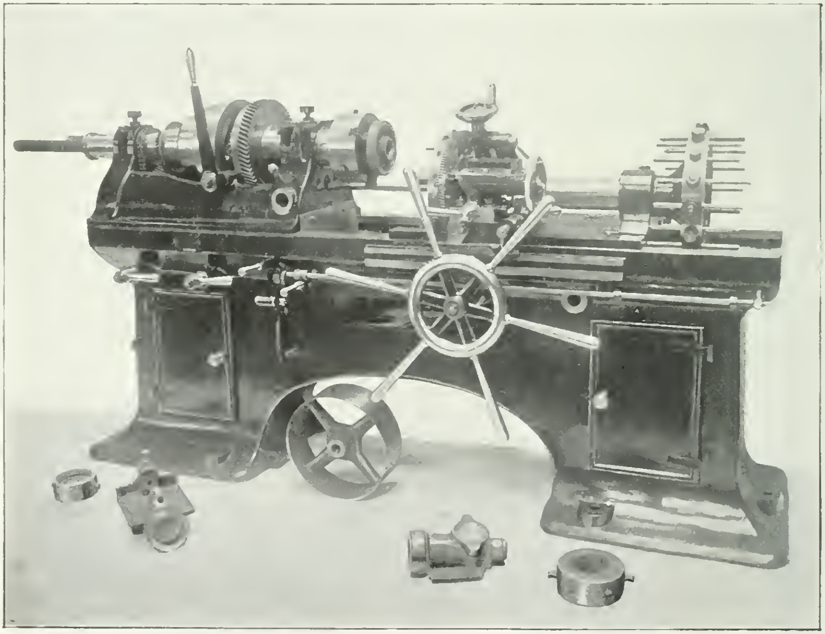
Again, all of the tools which make the best American shop practice what it is to-day depend on the presence of the thoroughly-skilled tool-maker in what may be termed commercial quantities. No manager is willing to install any system which depends on skill and ability beyond his own attainments, especially if the class of talent which must be employed is in limited supply. In this case, even if the manager is sufficiently venturesome to wish to drop his old routine in favor of an innovation, the mere fact that the working of the new method depends on one man, whom it is not easy to replace in case of accident or disaffection, is quite enough to forbid the change. No manager would willingly undertake a new scheme without a visible supply of the needful elements to carry it to success, and but very few successful managers are personally compounded of skilled workman and inventive talent in that degree which is essential to the creation of a first-class tool-maker. Within a very few years the "tool room," or special tool-making department, fully supplied with fine tools and containing really capable tool-makers, was a very rare feature even in the best American machine shops. Even now, though every shop of any pretensions to good management has a tool room, it is very often a mere exchange for issuing to the workmen small tools made elsewhere and taking them back again when the hands are through with them. Very often a tool-room is seen containing fine tools which are not in real use, because tool-makers capable of making them economical and valuable factors in the shop-production are not supplied. There is no more melancholy spectacle than a well-equipped tool room which is of no actual benefit to the concern owning it, and no more pitiful object than the manager who forgets the supremacy which must ever belong to the man of high executive ability, and secretly fears to employ really good tool-makers because he well knows that their special qualifications are beyond his own technical limitations.



BRASS-FINISHER'S CAPSTAN LATHE.

The turret carries six tools, and has longitudinal movement by lever or screw and traverse movement for facing, etc. Also swivels for boring or turning taper. James Archdale & Co.

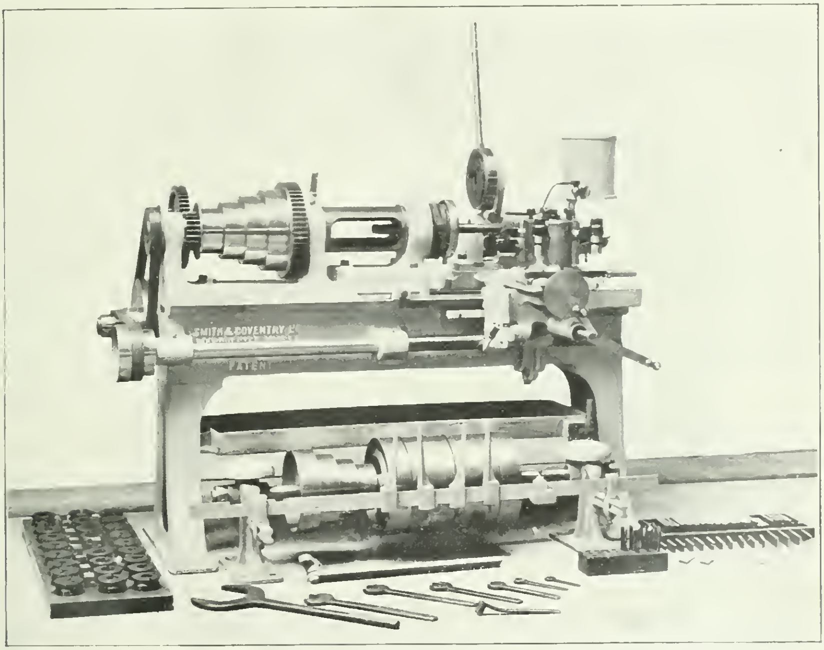
Semi-automatic machine tools, to within the last decade, demanded a well-equipped tool room, and an adequate force of good tool-makers for successful performance. This involved a large new departmental expense, not likely to be recouped by the employment of a few turret machines on a limited range of work. Now, the case is quite different. Competent tool-makers are present in almost every respectable shop, tools of precision are seen everywhere, the milling machine and the grinding machine are in common use, and, more than all else, two or three resolute and courageous inventors have applied themselves boldly and pertinaciously to adapting the turret to general machine-shop use, with such success that, in some instances, one single piece can be finished more quickly with the fixed cutters than by using the engine lathe. This means that a number of tools can be fixed in their proper positions, requiring a considerable expenditure of time on the part of the machine tender, and yet the actual finishing of the piece can be accomplished so much more quickly with the fixed cutters than by the repeated cuts and measurements needful with the engine lathe, that the total time consumed in producing the piece on the semi-auto-



A GERMAN REPETITION LATHE.

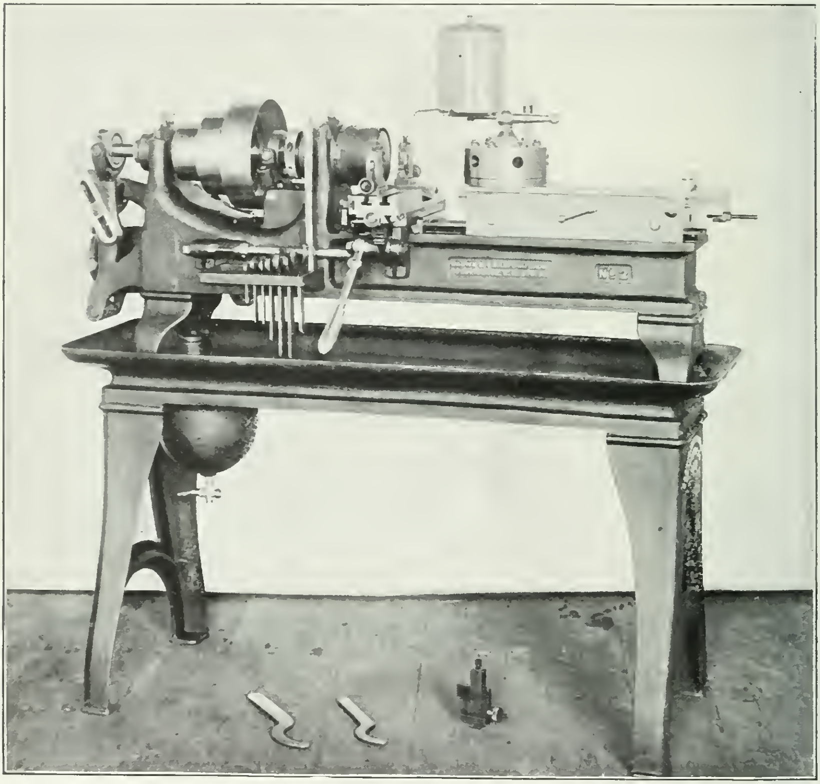
Made by the Leipziger Werkzeug-Maschinen-Fabrik (the Pittler Co.).

matic tool, tool-setting included, is less than that of a good turner, using a good engine lathe. It means also that great inventive skill, and that of the highest order, has been applied to the turret machines as originally produced, so that the skilled tool-maker's intervention is far less employed than anyone, however familiar with the use of the turret, would have deemed possible ten years ago. It is a case once more of high intelligence embodied in the machine in the form of superior tool-holding appliances, which permits the cutting tools themselves to be of the simplest possible description, and enables these simple tools to be accurately set and securely fixed in position, with the least possible expenditure of time and intelligence.



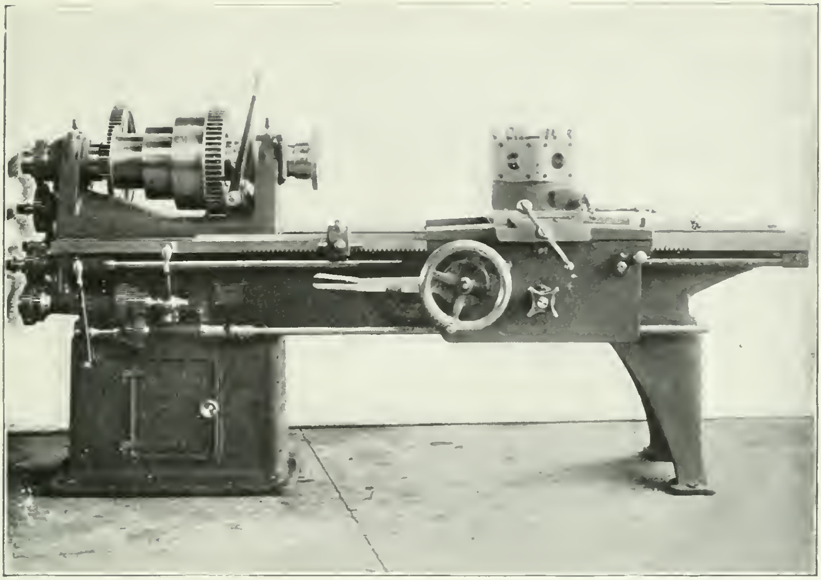
OPEN HOLLOW-SPINDLE STUD LATHE.
For making studs, screws, etc., from the bar. Smith & Coventry.

The first turret machines, like all engine lathes except those of the highest class worked under conditions of the most exceptional character, were incapable of producing screws having threads of standard form and accurate pitch. The early English tool-makers took great pride in their screws, which were, however, extremely imperfect. Even to-day good engine lathes with new lead screws cut very imperfectly-pitched screws, and where the lead screws are worn by use, they cut screws so far out of pitch as to lead to serious trouble in machine construction; hence the myriad contrivances in the way of nut fastenings to keep screws from working loose, an occurrence so common that it has passed into common speech, "a screw loose somewhere," meaning that, while all expected care has been used, failure results instead of success. This paper affords no space for a treatise on screw cutting, but it is enough to say in few words that a really accurate screw, true to pitch and thread form, is an almost impossible and almost unknown production, while true nuts which would accurately fit a true screw are even more rare. These troubles with screw forms are well known, and the leading mechanics of the world are widely separated as to the pitch for a given diameter and the form of



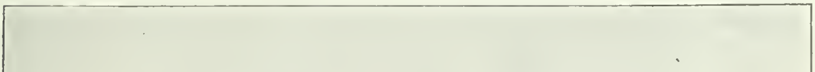
SCREW MACHINE WITH AUTOMATIC WIRE FEED.

For turning, facing, boring, screwing, tapping, or finishing small parts of machines or tools from bar stock or forgings or castings. Diameter of hole through largest feeding finger, ¾ in.; turns any length to 4 in. Brown & Sharpe Mfg. Co.



COMBINATION TURRET MACHINE. SWING 22-IN. DIAMETER AND BED 8½ FT. LONG.

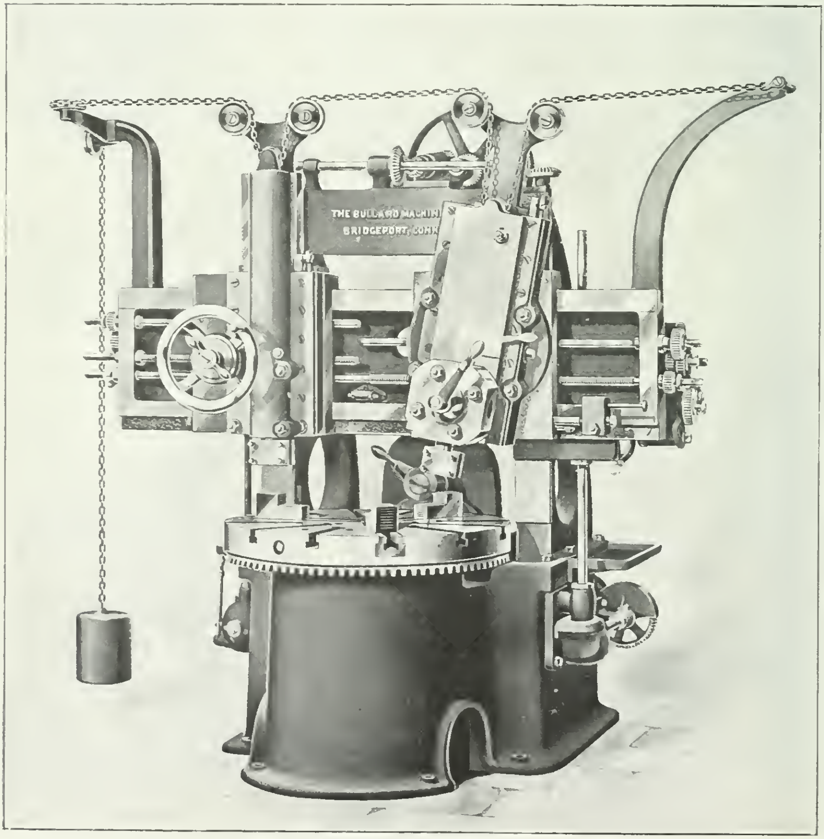
Hexagon turret 12-in. diameter with six 2½-in. holes, permitting a bar to pass entirely through the head. Bullard Machine Tool Co.



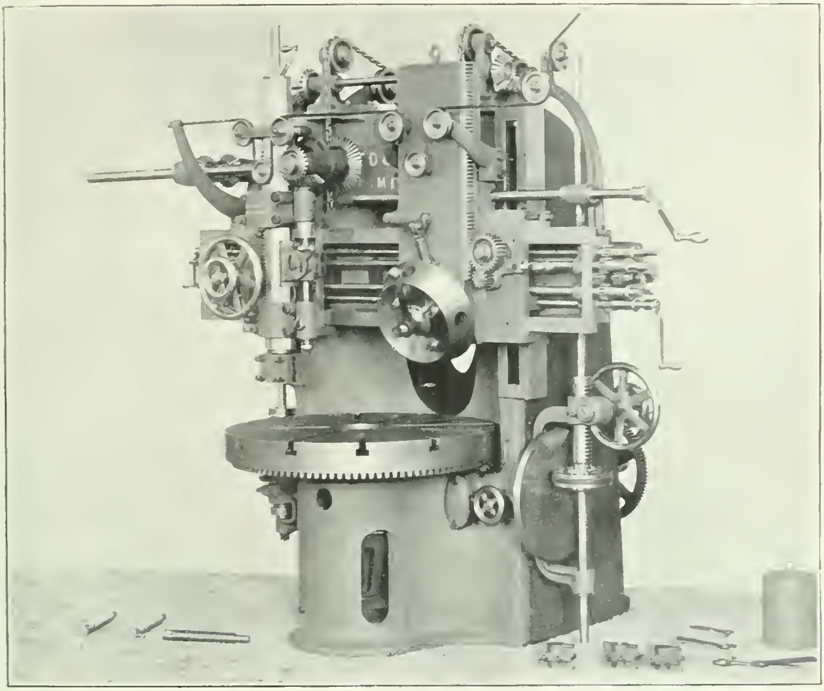
TURRET MACHINE WITH SWING 26 IN. OVER THE WAYS AND BED 10 FT. LONG.

The spindle has a hole 3⅜-in. diameter, and the hexagon turret has six 3½-in. holes The cross slide carries three tool posts. Turret unlocks and revolves automatically at any point between 8 and 22 inches. Bullard Machine Tool Co.

thread most suitable to use. The standard English thread, adopted first by Clement and made standard by Whitworth, has a round top and bottom with straight sides, and is an excellent form. The American standard thread, fixed by Sellers, has a flat top and bottom, connected by straight sides, and is also an excellent form, the Sellers system being marred, however, in my opinion by far too coarsely-pitched screws below ¾ ins. diameter. Much finer-pitched small screws are still in general use among the New England tool makers, and it would be advantageous to establish a second set of pitches for small screws. In America the worst of all possible screw forms is still used—the 60° angle V-thread, sharp top and bottom, which should be utterly discarded, as it is impossible of accurate production.



BORING AND TURNING MILL WITH ONE TURRET HEAD AND ONE SPECIAL HEAD.
The turret is square and has four 2½-in. holes. Capacity, 42-in. diameter and 30-in. height. Weighs 9,000 lbs. Bullard Machine Tool Co.

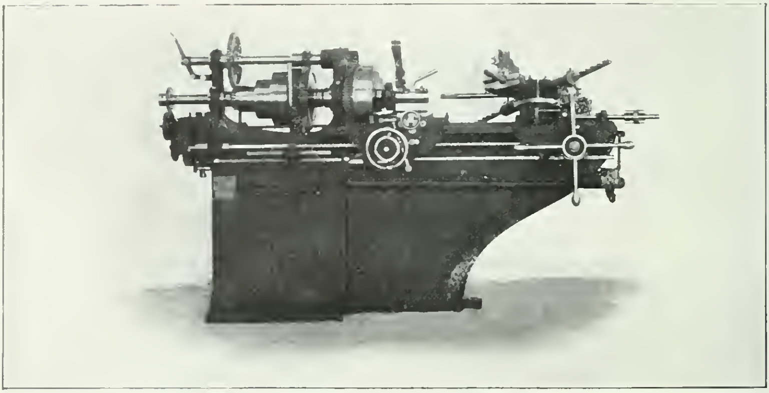


BORING AND TURNING MILL WITH TURRET ADAPTATION.

One head carries a turret and the other a thread-chasing attachment.
Made by the Niles Tool Works.

For all that is here said, the general character of screw threads and screw forms of body and head have been vastly improved by the general use of the turret machine in ordinary screw making, although no good very small screws can be produced on machines of this class. But for all ordinary machine sizes of screws, the flat-turret lathe as designed by, and built under the management of, James Hartness can and does produce screws more nearly approaching accuracy than any lathe in common use.

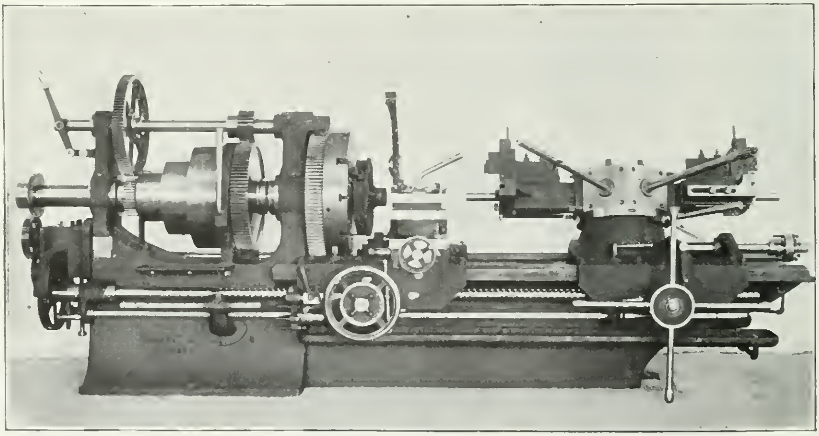
To reach this highly important result, Hartness began at the beginning, with the molecular constitution of his cutting dies, partly soft and partly hard so as not to suffer distortion in tempering, and followed this by a new method of cutting his dies, which renders accuracy possible and makes a close approach to accuracy inevitable. Next he changed the functions of his die threads, making some of them act as cutters while others act as guides, all in simple and certain ways, evincing the very highest powers of reasoning from



A SMALL SIZE OF THE GISHOLT TURRET LATHE.

cause to effect and of combining methods and means, with the magnificent industrial result of producing more generally-accurate screws in machine-shop sizes than ever before made, at a cost far below that of the most indifferently-cut screws made on an engine lathe, or on bolt-cutters of common description.

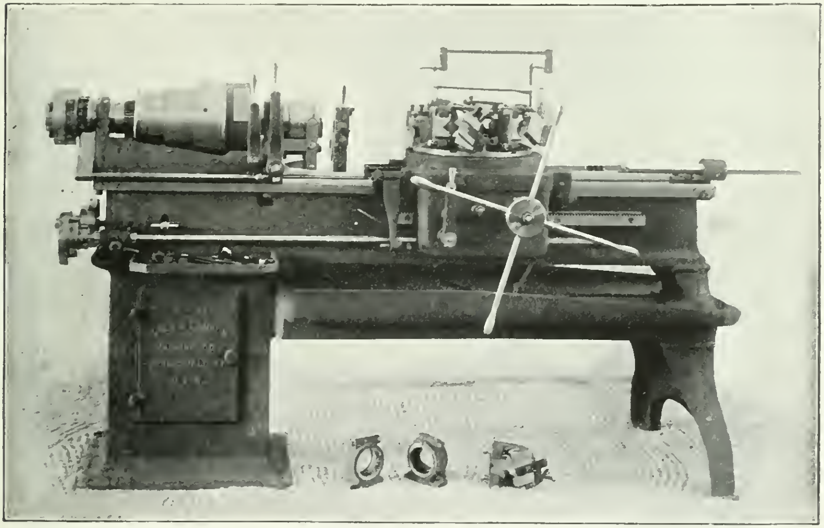
Like the legendary pilgrim of Kooru, who spent three thousand years in selecting and fashioning his immortal staff, Mr. Hartness has confined his attention to the production of a single tool, his flat-turret lathe, in one size only. The Hartness flat-turret lathe makes work from the bar up to 2-ins. diameter x 24-ins. length, and swings 16 ins. over the sheers and 14 ins. over the apron, for chucked



THE GISHOLT TURRET LATHE IN ITS LARGEST SIZE.

The turret is shown fitted with tools for special work of the character shown on pages 386 and 387.

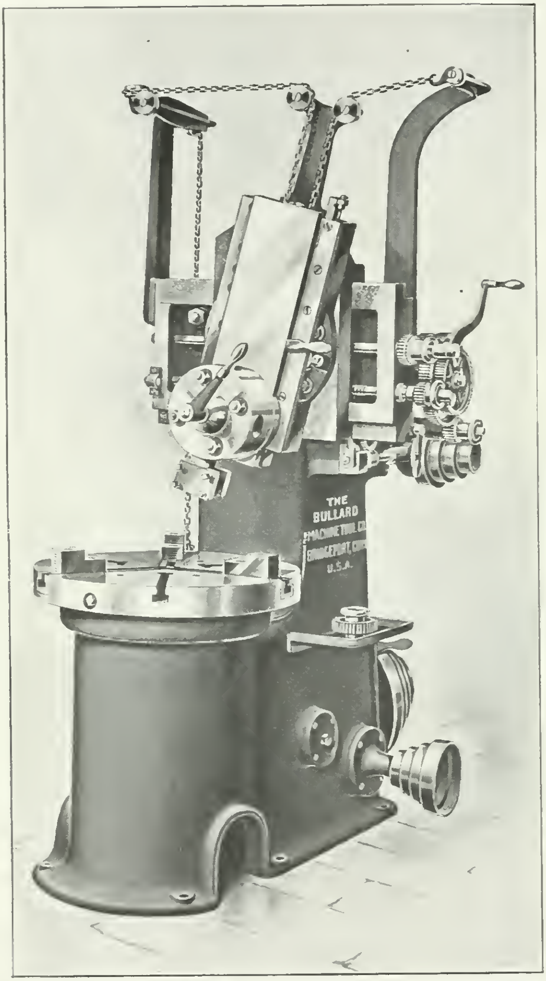
work. None of the highly interesting mechanical features of the lathe are here illustrated, preference being given to illustration of pieces produced by this tool, with the time of production given in each case, as being better calculated to direct the attention of shop managers to the labor-savings which can be made by the use of tools of this character. The work produced is as nearly accurate as that of good engine lathes, and the time consumed is but a fraction, and in most cases a small fraction, of that required by the lathe. The screw threads produced are far superior to any ordinary machine-shop work, and accurate screw cutting is of the highest importance both in the cost of machine production, and in the value and efficiency of the machine produced. While the flat-turret lathe can produce a great variety of chucked work very cheaply and accurately, it is chiefly intended for making work from the bar, to be finished inside of 2 ins. diameter x 24 ins. long. At first sight these seem to be small dimensions, and to afford but a narrow field for invention and for industrial application. In point of fact, however, these sizes include by far the larger part of all engine-lathe work done in all shops, and, in addition, the length may be very considerably extended to meet special cases.



THE HARTNESS FLAT-TURRET LATHE.

The turret is a flat, circular plate, mounted on a carriage containing the controlling mechanism. The form and connections are designed to secure great rigidity and accuracy. Cuts 2-in. diameter up to 24-in. length. Made by Jones & Lamson.

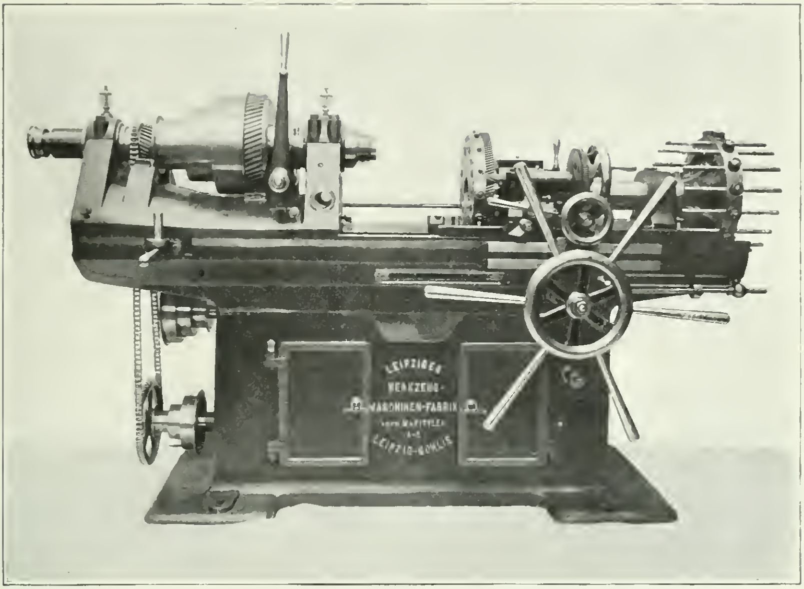
As to the field for invention afforded in the effort to produce a



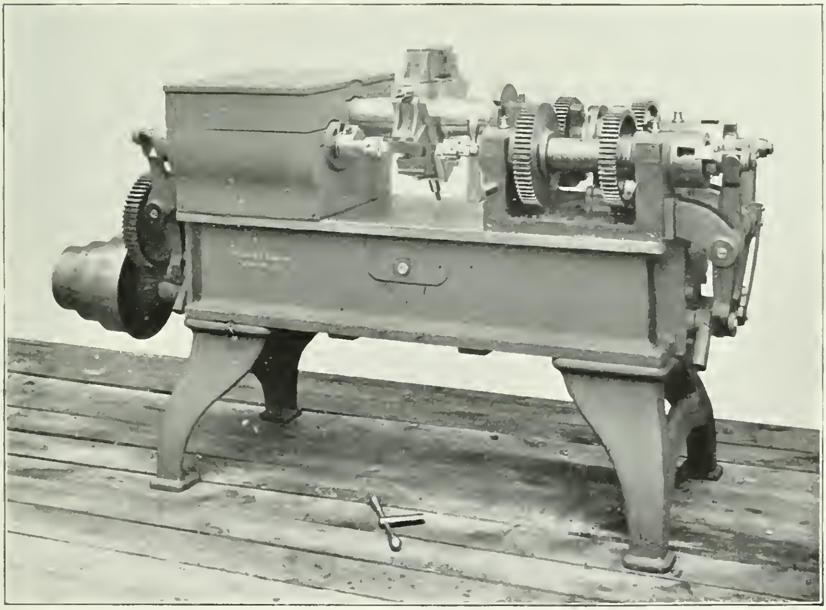
BORING AND TURNING MILL WITH SWIVEL TURRET HEAD.

Capacity, 30-in. diameter. Made by Bullard Machine Tool Co.

perfect tool of the flat-turret-lathe class, it is boundless. Successive efforts have been required in the bar-feeding means and in the chuck which grips the bar in the spindle, although the end seems now to be reached in a chuck which holds a bar of round, square, or hexagonal section with absolute certainty and rigidity, of any size from 2 ins. to ⅜ in. The screw-threading die is a marvel of simplicity and ingenuity, and the thread-cutting dies are perfectly interchangeable, and are readily sharpened, and this whole threading die, which is made almost entirely on the flat-turret lathe, and, I believe, wholly without hand fitting, is a really wonderful testimonial to the powers of the machine. In the flat-turret lathe the turret has been given a wholly new form, the turret base rising only a very little distance above the saddle gibbed to the sheers, which supports it so that the work passes over the turret base, and the tools do not overhang. The turret-turning action is so arranged that the turret stops only at the places required, instead of making idle stops; each tool travels the length of its own



THE PITTLER REPETITION LATHE.

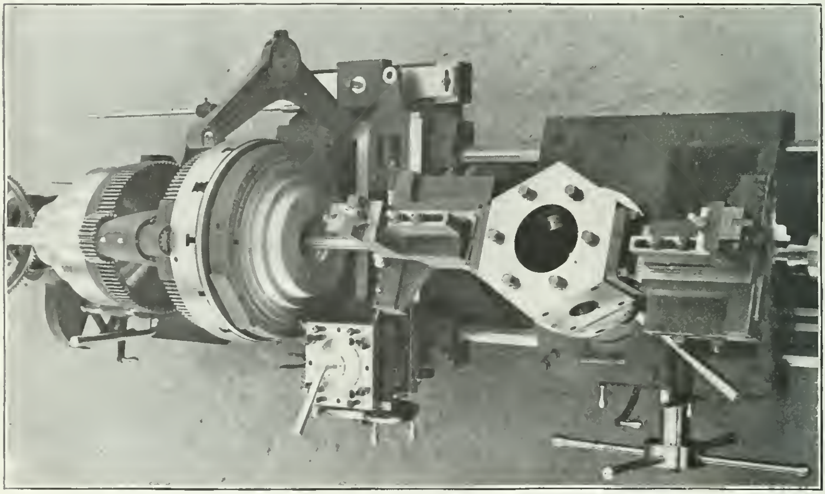


AUTOMATIC BORING AND TAPPING MACHINE FOR IRON OR BRASS WORK.

For boring, facing, chamfering, and tapping the pipe ends of valves, cocks, union nuts, etc. While one rough casting is being bored and faced the preceding one is being tapped, and the finished valve preceding that is being removed. Warner & Swasey.

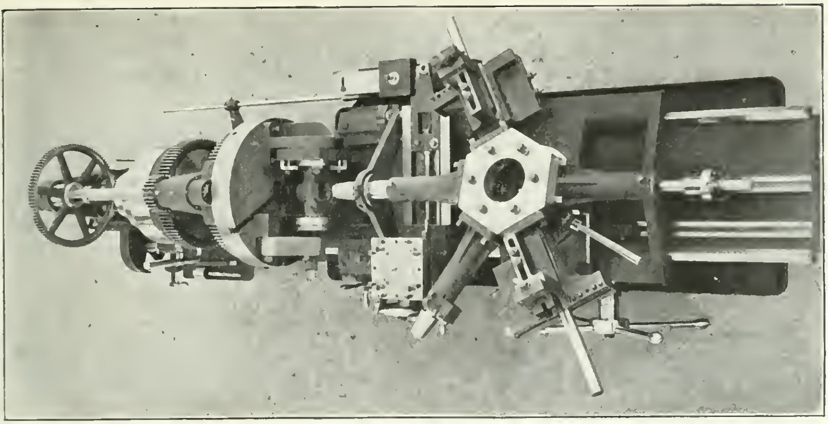
cut only, and the work is held firmly up to the tools; each turning tool and back rest is readily adjusted to any size; each position of the turret has an independent feed stop, and the turning tools are of the simplest form possible. Many of these highly-important features are impossible with the ordinary form of turret, and the flat turret makes new functions of the revolving tool-carrier practicable.

Thus we finally have a form of Maudslay's slide rest, equipped with Stone's highly-advantageous turret so as to carry a number of cutting tools, and through the Hartness devices and inventions we have both the tools and the work far better supported than is possible with any other form of metal-working tool in use, and these vast advantages, combined with the Hartness threading die, greatly superior to anything previously used, enable studs, shouldered bolts, handles, hollow pieces and long screws to be produced at a labor-hour cost which, even as late as 1890, would have been pronounced impossible by the most advanced constructor of machine tools. Indeed, it is even now almost impossible to believe that the pieces shown in the dimension drawings, p. 384-385, could have been produced in the times noted with each, and the machine-shop manager having only engine lathes for producing work of the class shown cannot study these simple drawings too carefully, as they will clearly show him that he is paying from four to ten times as much for labor on such work as he need pay.

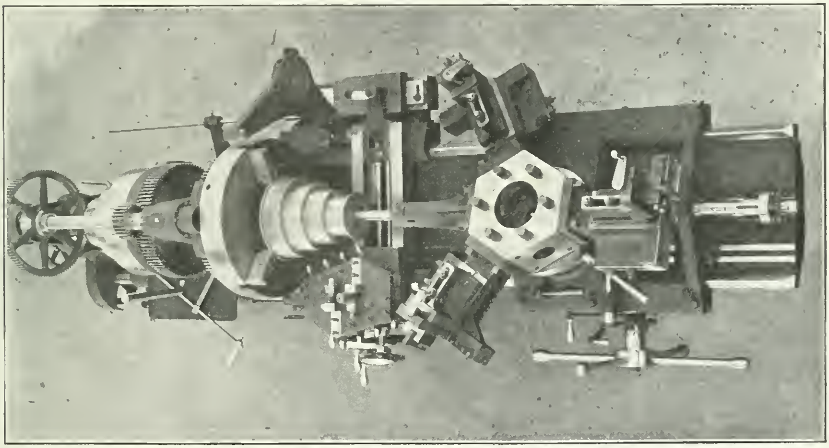


THE GISHOLT TURRET LATHE AT WORK.

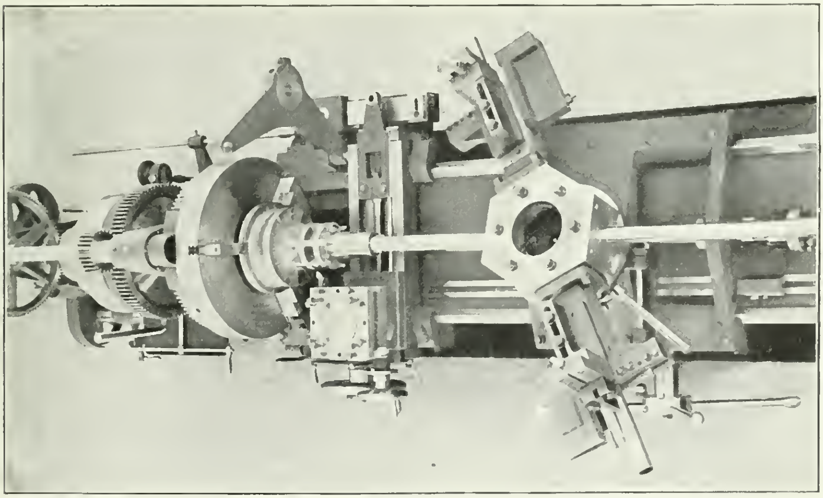
Equipped with tools for finishing cylinder heads (second operation). Columna Locomotiv Fabrik, Columna, Russia.



Tools set for finishing valves in the Maschinen Fabrik Augsburg, Augsburg, Germany.

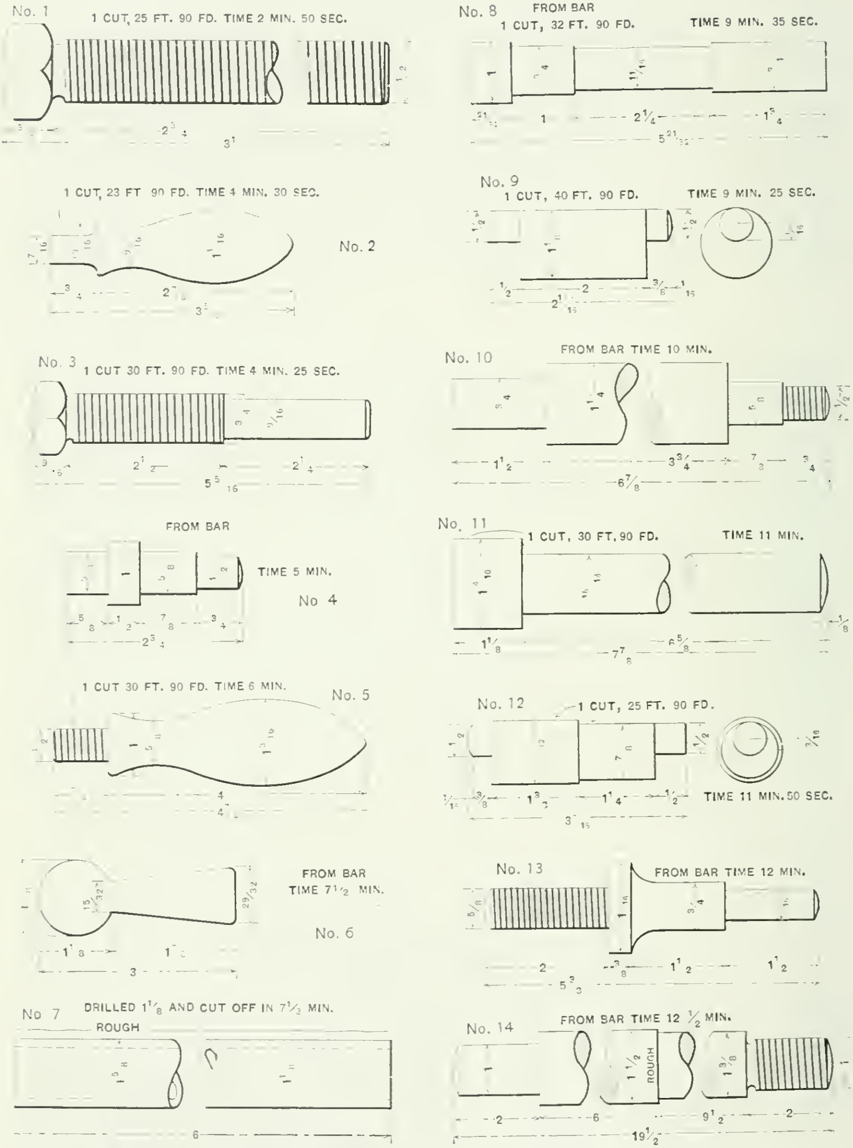


Arranged for turning cone pulleys in the shops of Ludwig Loewe & Co., Berlin, Germany.



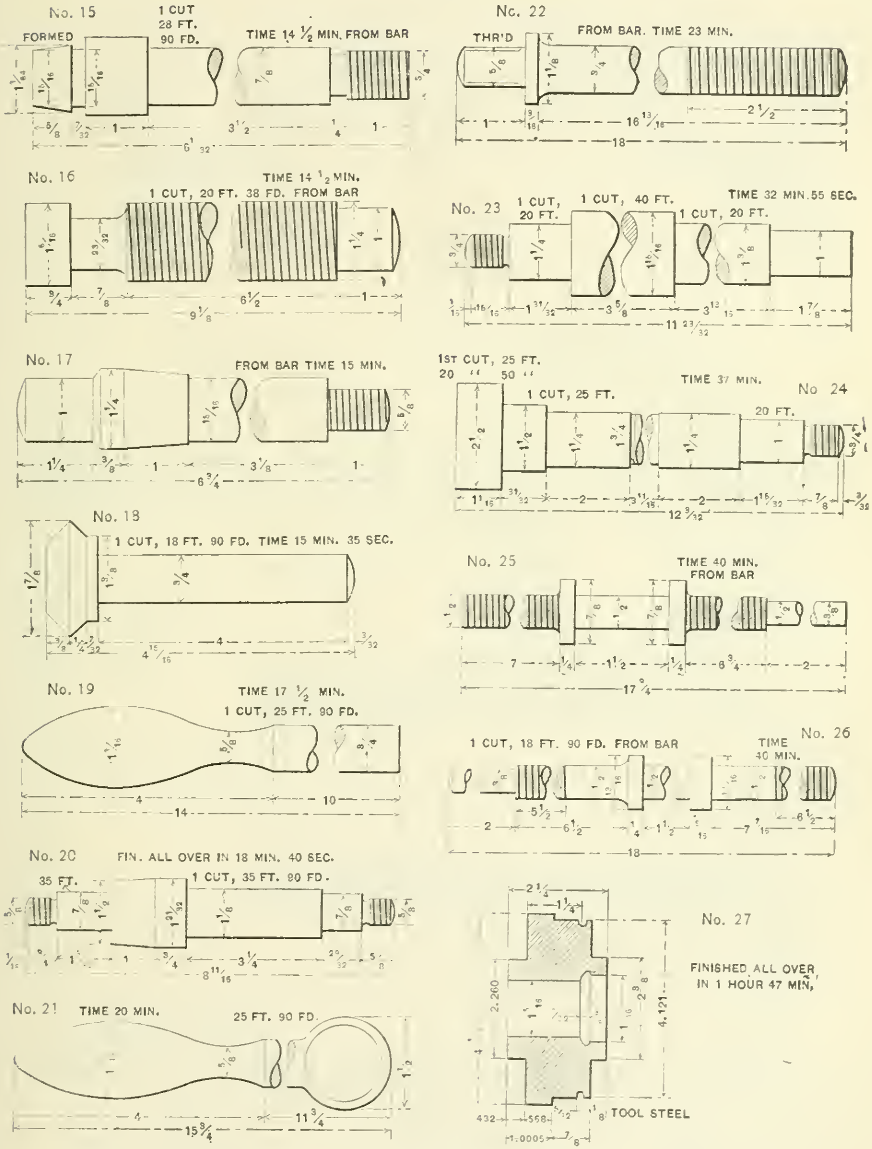
.Equipped for finishing commutator shells in the works of Postel Vinay, Paris, France.

TOP VIEWS OF THE GISHOLT LATHE, FITTED FOR SPECIAL WORK.



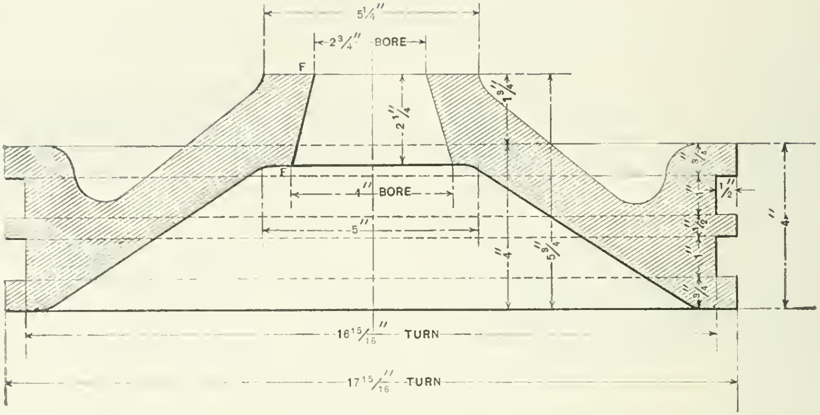
DIMENSIONS AND TIME COSTS OF WORK DONE ON THE FLAT-TURRET LATHE.

Take figure No. 1, for example—a plain, square-head, ½-in. screw, necked under the head, 3⅛ ins. over all. This screw was finished from a square bar in 2 min. 50 sec. No. 7, 1⅝-ins. outside diameter by 6 ins. long, has a hole 1⅛-in. diameter through it, and is bored and

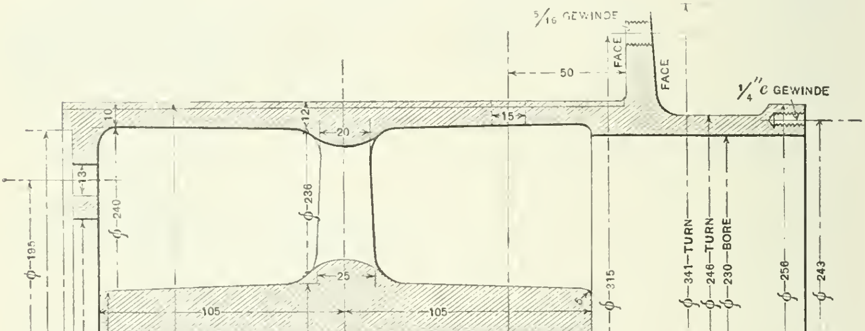


ADDITIONAL EXAMPLES OF AUTOMATIC PRODUCTION BY THE HARTNESS LATHE.

cut off in 7½ min. Nos. 25 and 26 are very elaborate, 17¾ and 18 ins. long respectively, shouldered and threaded, with reduced sizes between collars, and are by no means easy pieces for a good turner to produce, yet the lathe works them out from the bar in 40 min. each.



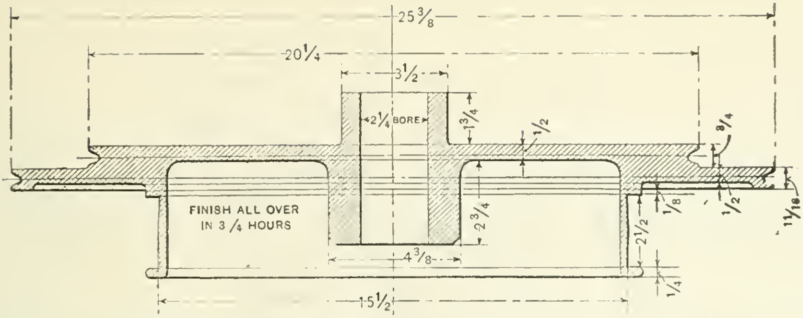
FINISHED AS INDICATED IN 1 HR. 20 MIN.



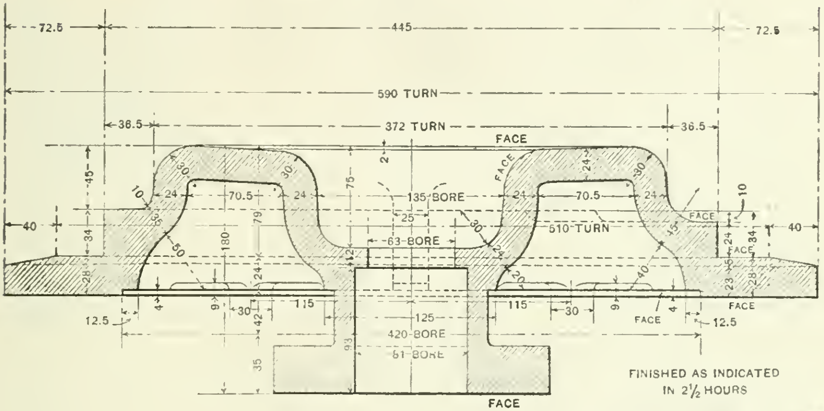
FINISHED AS INDICATED IN 1 HR. 10 MIN.

EXAMPLES OF THE WORK OF THE GISHOLT LATHE.

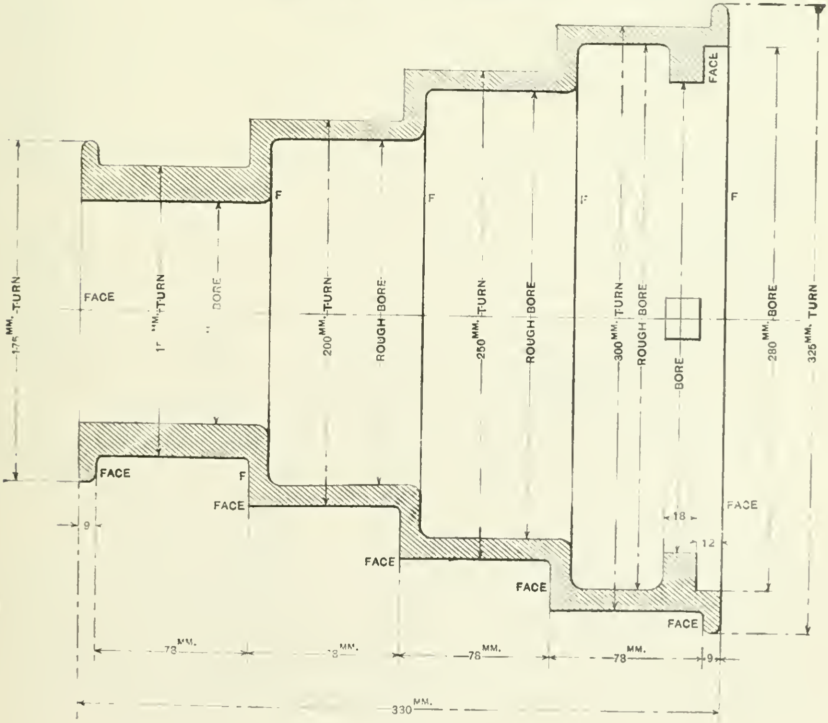
The figures above and on page 387 show the dimensions of large repetitive work—a piston special forms of pulleys and sheaves, cone pulleys, etc.—as finished on the Gisholt lathe, with the actual time required to finish each piece.



FINISH ALL OVER IN 3/4 HOURS



FINISHED AS INDICATED IN 2½ HOURS



TIME - 2 HRS. 45 MIN.

FINISHED AS INDICATED

The next important step in the development of cheap repetitive machine-part manufacturing was the adaptation of the turret-machine to do for separate cast-iron or cast-brass pieces what the Hartness flat-turret lathe does for parts produced from the forged bar, enabling all pieces of this class, within certain size-limits, to be finished far more rapidly than can be done on the best engine lathe, and also insuring accurate duplications. The Gisholt lathe is the pioneer example of this class, having large speed variations and great stability, with special appliances of a highly ingenious character devised specially to adapt it to the finishing of cone pullies, gear blanks, and other similar parts of machines. Although the Gisholt is not a "single production" machine shop, it is still so closely confined to one type as to fall easily into the class of highly specialized manufacturing. General views of the latter are given, with many scale drawings of work executed (p. 386-387), each marked with the hour-cost of finishing, the time expenditure being low in all examples, and in many cases surprisingly small. Where there are as many as five pieces to be duplicated a marked saving in time cost of production can be thus effected, and the examples given are highly instructive. Many other inventors and makers, American, English, and Continental were early in the field of turret-adaptation, with devices some of which are shown in the accompanying illustrations and many of which are marked by ingenuity and originality. Applications of the turret to boring mills and vertical drilling machines, in large and small sizes, extend to these tools the accurate repetition and rapidity of production which are the characteristic benefits derivable from the turret.

The turret has also been applied to metal-working tools, in which, instead of carrying separate tools successively to the work, the work itself is carried by the turret and thus successively presented to different cutting tools occupying fixed positions. This use of the turret has been confined principally to the finishing of valve bodies.

Thus through successive efforts of many skillful men, and a vast expenditure of thought and study and nearly a hundred years of time, the workman guiding a single cutting tool in the weak and uncertain grasp of his unaided hands, has been transformed into the workman controlling many cutting tools, all firmly held by the machine itself, and brought to bear upon the work in proper sequence, with the result of reducing the time-cost of the work-production vastly below the best that the most skillful hand-worker could do, while at the same time making far more accurate repetition work than is possible under any manipulation of hand-guided cutting tools.

ELECTROLYTIC PROCESSES IN INDUSTRIAL OPERATIONS.

By Dr. W. Borchers.

NO careful manager of a household, manufactory, or any business enterprise depending upon the consumption, exchange, or production of commodities will neglect to ascertain the best source of supplies. He will not only take care to purchase material at the proper time, but will also seize a favourable opportunity to acquire the apparently valuable commodity in more than sufficient quantity, provided he has the means and knowledge requisite to keep the surplus until the appropriate moment with its valuable properties unimpaired. This point of view is so natural that, wherever the conditions are approximately well regulated, it may be assumed as self-evident. And yet the greater the scope of our observation, the greater the enterprise whose economic management we are scrutinising, the more these self-evident principles of economy appear, or rather have appeared, to be put into the background. A contemplation of the prevailing method and means of utilising the so-called forces of nature—or, let us rather say, the available natural sources of energy—will show this most conspicuously.

The entire quantity of natural energy which we possess in the present condition of the earth's crust has its origin, as is well known, in the radiating energy of the sun. From the existing stores of heat in the interior of our globe we derive advantage at but a very limited number of places. Everything else which puts and keeps in motion the action of machinery, mechanisms, and living organisms is derived directly or indirectly from the sun. We distinguish:

1. Radiating energy, visible light and invisible rays ascertainable by their chemical or electric effects.
2. Heat.
3. Mechanical energy.
4. Electrical energy.
5. Chemical energy.

These various forms of energy may be converted more or less easily one into the other.

With exception of some forms of mechanical energy it is principally chemical energy only which can be stored in transportable form;

this is true of heat and electrical energy to so small an extent that they need not be here considered. The most fugitive of all forms is radiating energy. Let us note what becomes of this energy upon striking our globe. One part of it is at once converted into heat, in which form it penetrates to a moderate depth into the earth, doing work which is partly mechanical, partly chemical. The mechanical work consists chiefly of the evaporating and lifting of water. If we assume a mean rainfall of one metre and the height of the clouds at 3,000 metres, the work done by the sun equals 661,560,000,000 h. p. per second. Only a vanishingly small part of this labour can be utilised by us, but to-day the attempt is made to seize it wherever it can possibly be caught.

Not less noticeable a part of the sun's energy is directly or indirectly converted into chemical energy. Through the reaction taking place in the bodies of plants, and simply expressed by the formula $6CO_2+5H_2O=C_6H_{10}O_5+6O_2$, we obtain wood and other plant fibres, starches, and similar substances with considerable stores of energy suitable for creating heat in and outside of our bodies.

It has been proved that about one kilogram of wood can be made to grow annually on one square metre of suitable soil. From one square kilometre of wood or farm land we accordingly obtain 1,000 tons of vegetable matter with a thermal value of 4,000 calories per kilogram. This is equivalent to a continuously-working power station of about 700 h. p. Assuming but a very small proportion of the entire terrestrial surface of 136,038,872 sq. km. to be capable of supporting vegetation, we would in this case also reach an imposing figure. For many thousands of years this vegetable growth, with its incident mouldering and decaying processes, has been in operation as a sunlight accumulator, gathering into the earth's crust stores of energy in the form of peat, lignite, coal, etc.

Up to the present time we have consumed principally the last named stores, and that in no economical manner, using the most of the best, because considerations of transportation required the greatest possible storage of energy per weight unit. The turf and coal beds of lower calorific value have hardly been noticed, and large industrial centres have been developed only upon the richer coal basins. No reproach is hereby intended against the old working methods of industry nor against our old and accustomed manner of life, even though, here and there, the waste was greater than necessary; because, as I have previously stated, in order to make a favourable bargain-purchase, there must first exist the possibility of preserving the purchased supplies in such manner that they always represent at least the expended cost. Such a possibility, however, was out of the question until within the last few decades, only the most favourable opportunities offered us by nature to draw upon cheap and available powers having been utilised, and these mainly water powers. A point here or there, situated near the great thoroughfares of commerce, has already admitted of a better exploitation of a water power, but on the whole, notwithstanding the best intentions and an active spirit of enterprise, there has been a lack of effective work.

The evanescent mechanical energy of flowing water is irrevocably lost with every quantity of water which flows past unused. The same is true for various peat and lignite beds lying near the surface and exposed to the air. Their heat-producing qualities are so low that it is impracticable to transport them, and they certainly gain nothing through the influences of the atmosphere. Because of their diminishing value, these stores of energy must also be considered as temporary and their application for useful work, from a politico-economical standpoint, should be estimated accordingly.

At the present time, however, we have the means to bring into collected and portable form these benefits constantly coming to us from the sun, even though they can be seized only at the moment when, and the place where, they reach us. At the moment when Werner von Siemens created electro-technology by the invention of a practical dynamo-electric generator he also created the field for the development of the electro-chemical industry. On a moderate scale, this field had long been prepared by the labours of Davy, Faraday, Bunsen, Deville and others.

The true function of the electro-chemical industry is to give a concentrated and highly potential form to the fleeting processes of the forces of nature. The most desirable achievement of electro-technology is to bring the great water powers to existing industrial centres, but in this matter we cannot exceed certain rather narrowly-set limitations, and at best we are always dependent upon the copper leading-string which carries the impulse from the sources of energy. The necessary freedom of action desired for so many cases is here found lacking. No such limitation attaches to the production of the electro-chemical technology. Let us therefore inquire into the present achievements of this branch of industry, which have been accomplished in the short period of a development of about thirty years, and into its future possibilities.

At the beginning of the present year I collected extensive data for a report to the German Electro-Chemical Society, and I have collected the results in the following tables. Table 1 enumerates the more important metals and chemical products, obtained either wholly or partly by electrical means, with a statement of the amount actually produced or producible in the near future.

The figures in the table give the minimum, not the maximum, quantities. Producers from whom insufficient information, or none, was obtainable have remained unnoticed.

TABLE I.

	Weight, Tons.	Price per Ton, Marks.	Total Value, Marks.
Aluminum	12,930	2,100	27,153,000
Gold	kg. 21,320	2,800	59,696,000
Copper	166,360	1,500	249.540,000
Sodium	260	4,500	1,170,000
Nickel	182.5	2,500	456,250
Phosphorus	?	4,000	....
Silver	kg. 1,475,000	81	119,475,000
Zinc	?	560	....
Caustic Soda—70 per cent	82,060	153	12,555,180
Caustic Potash—80 per cent	17,280	370	6,393,600
Chloride of Lime—38-40 per cent	225,000	100	22,500,000
Chlorate of Potash	11,350	655	7.434,250
White Lead	2,500	450	1,125,000
Calcium Carbide	256,244	300	76,873,200
Carborundum	1,585	1,000	1,585,000

NOTE.—In this table the metric ton of 2,208 lbs. is used. The mark may be taken as 1*s*. or 25c.

Before analysing the figures in this table at greater length the various processes by which these products are obtained will be briefly described. Of the metals of the alkalies, sodium alone need be considered. In all known manufactories it is produced by the Davy (1808) process of electrolysis of caustic soda. The first serviceable apparatus for this process was constructed by H. Y. Castner, and consists of an iron plunger introduced through a tubular support at the bottom of an iron crucible. This plunger is placed vertically in the axis of the crucible and serves as the negative pole (cathode). An iron body fastened to the lid of the crucible surrounds the piston and acts as the positive pole (anode). In the lid, and above the cathode, hangs a receptacle which collects the melted metallic sodium coming to the surface from the cathode during electrolysis, and out of it the metal is ladled. The heating of the apparatus is so contrived that the melted charge poured into the crucible solidifies in the lower portion and remains solid during the electrolysis, thus effecting insulation and sealing the joint; while the sodium and hydrogen are isolated at the cathode, oxygen is collected at the anode. To separate the latter as much as possible from the sodium, a cylinder of wire gauze is hung between the electrodes.

Other very suitable devices have more recently been constructed by Rathenau, Suter, and the Aluminum Industry Stock Company on the one hand, and by Becker on the other. The former recommend the use of cathodes with round or conical heads dipping but slightly into the electrolytes. From time to time the metal is ladled from the cathodes and separated from the accompanying impurities.

Becker's apparatus is a modification of Castner's, and enables the principal parts to be more easily maintained at the required temperature while at the same time it is sought to make the collection and removal of the metal easier.

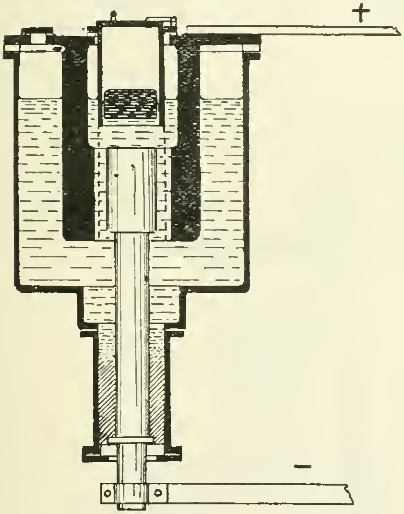


FIG. 1. CASTNER'S SODIUM APPARATUS.

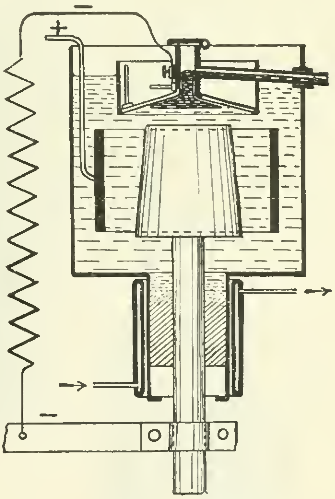


FIG. 2. BECKER'S SODIUM APPARATUS.

Though no figures showing the extent of the production of magnesium were procurable, we must not omit to mention it. It is one of the metals that has been obtained from melted salts by electrolysis in scientific laboratories as well as in commercial practice. The present process of obtaining it is founded upon the investigations of Bunsen, who in 1852 obtained magnesium from melted magnesium chloride by electrolysis, and upon those of Matthiessen, who a few years later proposed, as a source of magnesium, carnallit (magnesium sodium chloride) from which the moisture is more readily removed than from pure magnesium chloride. The apparatus used is an iron crucible serving at the same time as a negative pole during the electrolysis; a carbon rod, hung in the crucible, forms the anode. The magnesium is deposited in the form of balls on the walls of the crucible, and the chlorine is carried off from the vicinity of the carbon rod through porcelain tubes.

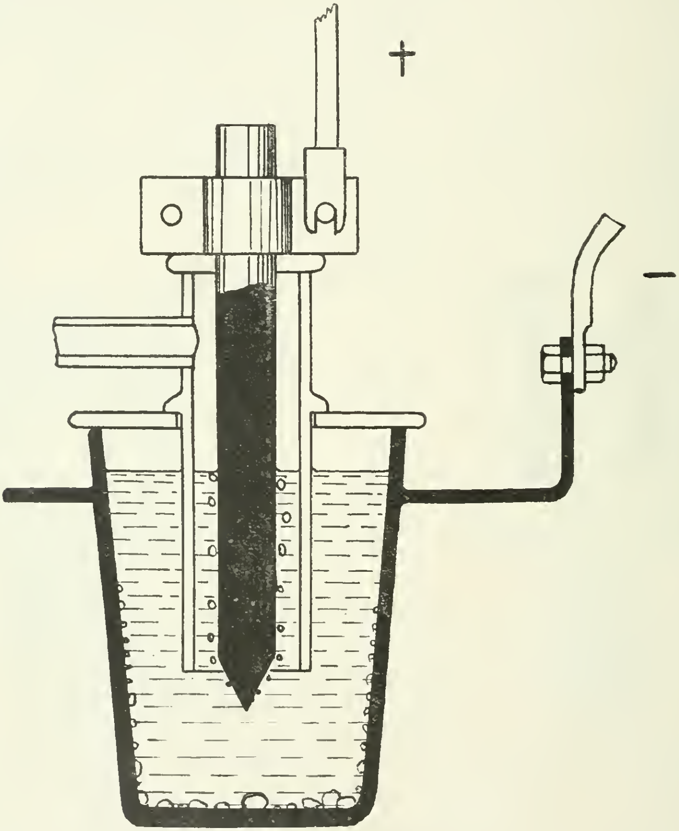


FIG. 3. CRUCIBLE FOR ELECTROLYTICALLY EXTRACTING METALLIC MAGNESIUM.

The preliminary conditions for the manufacture of aluminum were also given in the works of Bunsen and St. Claire-Deville in the year 1854. These two scientists had already proved that aluminum could be separated from its fused compounds by electrolysis. Deville had already made experiments to replace the aluminum removed from the fused mass by adding its oxide, thus making the process a continuous one. But as the cost of electricity for the purpose of heating the charge was prohibitive at that time, crucibles heated by firing from the outside had to be used. No material for a crucible could be found which, when filled with melted chlorides and fluorides and heated from without, could withstand the influence of the charge, and would not fill the metal with impurities. Héroult suggested the idea of doing away with external heating by melting the electrolyte and keeping it in melted condition by the heat electrically generated by the electrolysis current; this made possible the present development of the aluminum industry. According to Héroult's process, cryolite is melted first by the electric-light arc in an iron box lined with carbon, the fusion being continued later by the heat produced by the resistance, the charge between the electrodes itself furnishing the resistance. The crucible lining, particularly the bottom lining, forms one of the electrodes, and one or more bundles of carbon plates the other.

During electrolysis a pre-determined quanaity of aluminum oxide is at short intervals introduced into the charge as compensation for the aluminum removed. The metal collecting at the bottom of the crucible is from time to time drawn off through a tap hole.

Deviating from Héroult's furnace, Borchers, with a view of increasing the purity of the metal obtained, recognised the value of lining the crucible with cryolite. The charge in the crucible and the separated metal come in contact only with a pure aluminum compound.

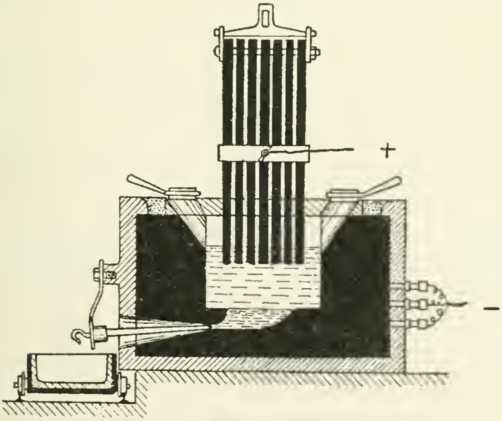


FIG. 4. HEROULT'S ALUMINUM FURNACE.

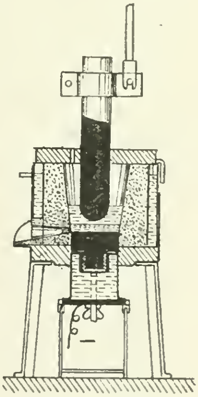


FIG. 5. BORCHER'S ALUMINUM FURNACE.

A metal or carbon pole, introduced through the bottom, serves as the cathode. To preserve the aluminum from taking up impurities by coming in contact with these parts of the apparatus, the poles are sufficiently cooled to prevent any chemical combination occurring there.

Hall's process, which is that of the Pittsburgh Reduction Com-

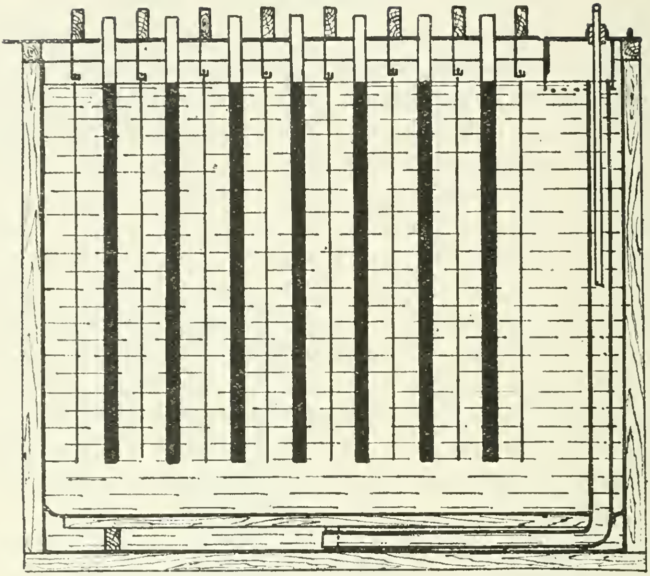


FIG 6. COPPER-REFINING VAT. LONGITUDINAL SECTION.

pany in the United States, also differs from Héroult's by using, as electrolytes and solvent for the aluminum oxide, a mixture of chlorides and fluorides of the metals of the alkalies and alkaline earths.

Copper, nickel, silver, and gold, in so far as electrolysis may be said to be applicable to them, are chiefly obtained in pure form by electrical means from the crude metal produced by the smelter. Gold is also electrolytically deposited from weak solutions obtained by chemical lixiviation processes. In the process for refining the crude metal it is cast into plates, with hook- or eye-formed projections by aid of which the plates are hung upon the electrical conductors. The latter generally rest on insulating wooden frames on the edges of the vats in which the electrolysis is carried on. Aqueous solutions of salts of the respective metals—for instance, sulphate of copper, sulphate of nickel, cyanide of nickel, nitrate of silver, chloride of gold, etc.—are used as electrolytes. The copper, silver and gold solutions are kept highly acid, the nickel solutions as a rule neutral. Plates of the pure metal serve as cathodes and are hung into the bath alternately with the anodes. It is important for the success of the electrolysis that more or less active agitation of the solutions be maintained. This is obtained either by the continual circulation of the solutions through a series of vats, by air-blasts, or by stirring. In the separation of silver and gold the agitators covering the cathodes are shaped somewhat like clasps, serving the additional purpose of breaking off the silver crystals, which form like needles, and of preventing short circuits.

Zinc, up to the present time, has been obtained only in large laboratories by electrolysing the lixiviates obtained from the roast products of poor ores after careful cleaning; using insoluble anodes of carbon or lead. Tin is principally obtained electrolytically from tin-plate waste. This is pressed into balls and then placed in solutions of caustic soda and sodium stannate in baskets of wire netting which serve as anodes. The iron tank and the suspended iron plates serve as cathodes.

Caustic soda, caustic potash, chlorate of potash, and chlorine are obtained by electrolysis from aqueous alkali-chloride solutions, the chlorine being produced at the anode and the hydrogen, together with the caustic alkali, at the cathode. By suitable constructive appliances or apparatus, and by changing the working conditions, the chlorine and caustic-alkali solution are either carried off separately, converting the former into chloride of lime and the latter into solid caustic soda, or the chlorine and caustic alkali are permitted to influence each other during the electrolysis so that the apparatus produces a solution of chlorate of potash in the place of caustic potash and chlorine. For the first-mentioned process, apparatus is operated by the Aktien Gesellschaft Elektron, Frankfort a. M., by Castner, Kellner, Solvay & Co., Elektrochemische Werke, Bitterfeld, Le Sueur, Hargreaves & Bird, and Richardson & Holland; for the last-named, by Gall & Montlaur, Corbin, Ver. Chem. Fabr. Leopoldshall, Oettel, Hargreaves, and Blumenberg. It would lead us too far to describe all of these in detail. In principle, the various apparatus for obtaining caustic alkali differ

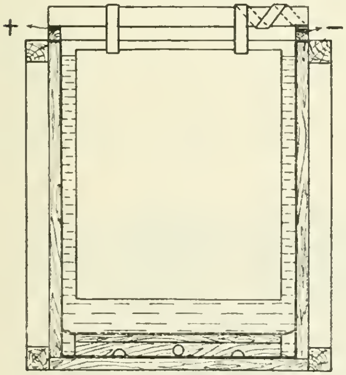


FIG. 7. COPPER-REFINING VAT. VIEW OF CATHODE.

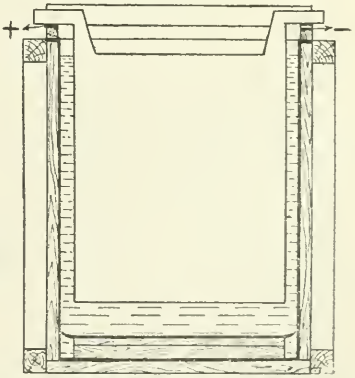


FIG. 8. COPPER-REFINING VAT. VIEW OF ANODE.

among each other in this particular—that the separation of the products is accomplished either by porous diaphragms or by means of quicksilver as a middle electrode.

In the case of a vessel with two communicating partitions, the communication may be cut off by quicksilver; if the one partition then contains salt solution with the anode, and the other water with the cathode, the layer of quicksilver opposite the anode becomes electrically negative and absorbs the alkali metal which it then discharges at its positive electrical side, opposite the cathode, in the other partition, for the formation of caustic potash and hydrogen.

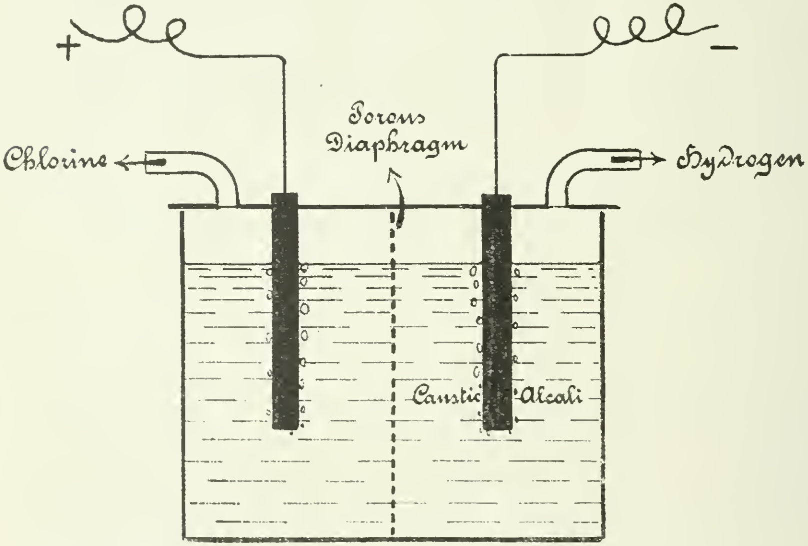


FIG 9 ALKALI AND CHLORINE ELECTROLYSER WITH POROUS DIAPHRAGM.

To obtain chlorate, the diaphragms and other partition walls for the different products of the electrodes are not required, because the chlorine formed at the anode combines with the alkali at the cathode to form an alkali chlorate.

In this case, therefore, the only precautionary measure to be taken is to arrange the cathode and to choose the other working conditions in such a manner that the hydrogen, produced with the caustic alkali at the cathode, can not cause a reduction of the newly-formed chlorate.

White lead is obtained by a process originally mentioned by Luckow, by electrolysing anodes of lead opposite inactive cathodes in a weak solution of chlorate of potash and carbonate of soda. The neg-

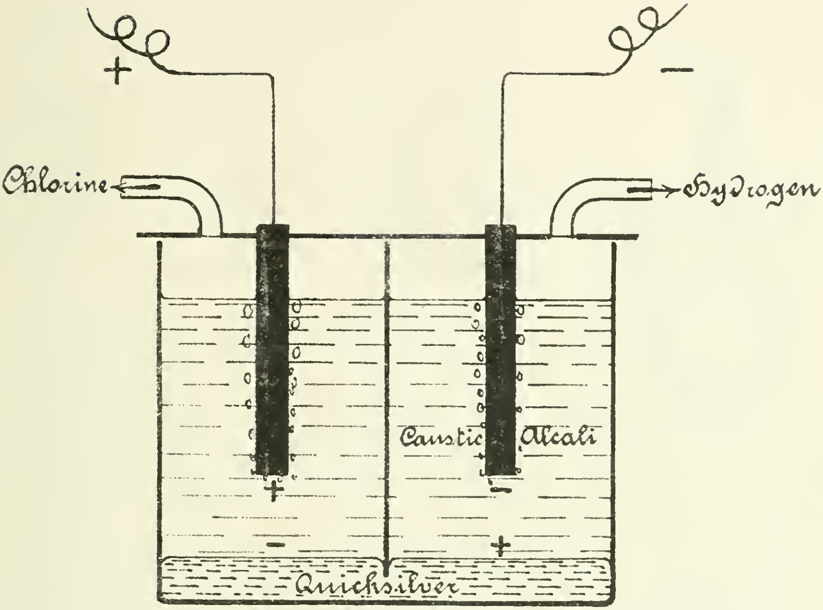


FIG. 10 ALKALI AND CHLORINE ELECTROLYSER WITH QUICKSILVER DIAPHRAGM.

ative constituent of the chlorate of potash promotes the solution of the lead, which is then deposited again through the negative constituents of the sodium carbonate as white lead. In addition to the renovation of the lead anodes, carbonic acid and water must constantly be added.

The methods of producing phosphorus, carborundum, and calcium carbide are purely chemical reduction processes carried on by means of electrically-generated heat. The heating is either brought about by incandescent heating, by placing, in the case of carborundum or calcium carbide, the reduction carbon or special carbon with the desired compound, in the path of a strong current or, in the case of phosphorus, or calcium carbide, by producing one or several electric arcs inside the mass. For this reason, several modifications appear in the various furnaces. The fused product either collects in the furnace, or is tapped off from time to time in

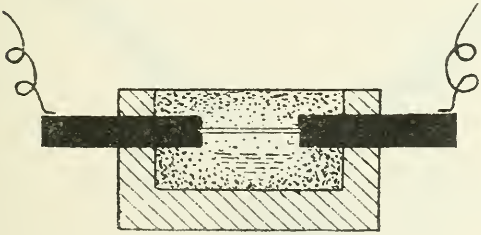


FIG. 11. ELECTRIC FURNACE. INCANDESCENCE HEATING.

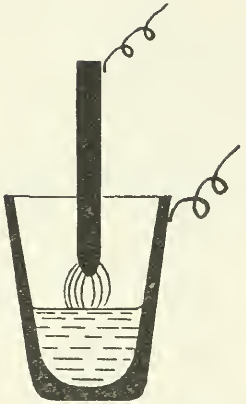


FIG. 12. ELECTRIC FURNACE. DIRECT ARC HEATING.

the manner employed with metallurgical melting furnaces, or is constantly withdrawn by moveable hearths. Other variations are caused by the use of moveable electrodes. For practical purposes the furnace system of Borchers for calcium carbide and carborundum is still further developed, and the furnace system of Siemens for calcium carbide, phosphorus, and many other smelting operations.

That all the products mentioned are merchantable and valuable wares needs no further elaboration on my part. Even those of my readers who are unfamiliar with the metal and chemical trade will find in the above list the names of products the uses of which are well known to them.

Three not unimportant branches of electro-chemical technology—namely, the accumulator industry, the galvano-plastic industry and the well-developed electric-bleaching processes—I must to my regret leave unnoticed, because of the great number of small plants, which cannot be investigated. That the last-mentioned industry, whose development is of but recent origin, is already in extensive operation, appears from the fact that the firm of Siemens & Halske in Berlin and Vienna, and the Elektrische Aktien Gesellschaft (formerly Schuckert & Co.) have installed plants of much more than a thousand h. p. The galvano-technical plants can also be counted by thousands.

The apportionment of the productions just named among the principal countries is shown in Table No. II. The power employed for this production is stated in Table III.

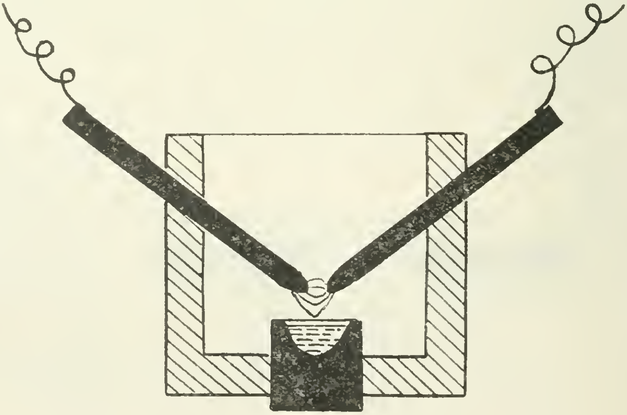


FIG. 13. ELECTRIC FURNACE. INDIRECT ARC HEATING.

TABLE II.

		Aluminum.	Gold.	Copper.	Silver.	Chlorate of Potash.	Caustic Potash, 80 per cent	Caustic Soda, 70 per cent.	Bleaching Powder, 40 per cent.	Calcium Carbide.	Carborundum.	Miscellaneous.
AFRICA.												
Transvaal...	Weight		10,320									
	Value		28,896,000									
AMERICA.												
Canada	Weight									1,500		
	Value									450,000		
United States.	Weight,	5,000	7,000	150,000	1,400,000	330		5,120	11,200	60,000	500	Nickel, 182.5
	Value,	10,500,000	19,600,000	225,000,000	113,400,000	216,150		783,680	1,120,000	18,000,000	500,000	456,250
EUROPE.												White Lead.
Belgium	Weight							1,600	3,500			
	Value							244,800	350,000			
Germany	Weight		4,000	13,600	75,000	120	17,280	2,600	51,200	12,444	225	2,500
	Value		11,200,000	20,400,000	6,075,000	78,600	6,696,600	397,800	5,120,000	3,733,200	225,000	1,125,000
England	Weight,	1,000						11,200	24,500	8,100		Sodium, 260
	Value,	2,100,000						1,713,600	2,450,000	2,430,000		1,170,000
France	Weight,	6,120				6,300		45,280	99.030	35,000	800	
	Value,	12,852,000				4,126,500		6,927,840	9,905,000	10,500,000	800,000	
Italy	Weight			560						29,450		
	Value			840,000						8,835,000		
Norway	Weight									24,500		
	Value									7,350,000		
Austria	Weight			1,000		750		7,200	15,750	21,000		
	Value			1,500,000		491,250		1,101,600	1,575,000	6,300,000		
Russia	Weight			1,200				2,400	5,250	6,000		
	Value			1,800,000				367,200	525,000	1,800,000		
Sweden	Weight					2,000				25,000		
	Value					1,310,000				7,500,000		
Switzerland	Weight,	810				1,850		3,300	7,200	28,250		
	Value,	1,701,000				1,211,750		504,900	720,000	8,475,000		
Spain	Weight							3,360	7,350	5,000		
	Value							514,000	735,000	1,500,000		

Weights of gold and silver are given in kilograms; of all the other metals in metric tons of 2,208 lbs. The value of the mark may be taken as equal to 1*s.* or 25c.

TABLE III.

The Countries Named Below,		Have in Power Plants Already Built or Projects Undertaken,			The Value of the Foregoing Installations Being, in Marks,
		Water Power, h. p.	Steam Power, h. p.	Gas Power. h. p.	
AFRICA.	Transvaal	....	454	....	28,896,000
AMERICA.	Canada	1,500	....	....	450,000
	United States	72,300	11,750	2,500	390,025,760
EUROPE.	Belgium	....	1,000	....	594,800
	Germany	13,800	16,173	....	55,138,200
	England	11,500	8,150	20	9,083,600
	France	110,140	1,300	....	45,111,340
	Italy	29,485	....	....	9,675,000
	Norway	31,500	....	....	7,350,000
	Austria	29,000	23	....	10,967,850
	Russia	6,075	1,500	....	4,492,200
	Sweden	27,000	....	....	8,810,000
	Switzerland	38,950	....	....	12,612,650
	Spain	7,100	....	....	2,749,080

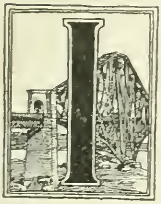
NOTE.—In this table the metric h. p. of 31,500 foot-pounds is used. The mark may be taken as 1*s*. or 25c.

Whoever has the interest to go more fully into the figures collected in the preceding tables will doubtless be able to gain many useful lessons therefrom. A particularly interesting comparison, for instance, is that of the natural sources of power of the various countries named with the value of the production obtained. Hastening, however, to the conclusion of my present remarks we come to a question becoming daily more acute: Where can we find the sources of power for our branching industries, more particularly for the young and rapidly growing electro-chemical industry? If we sum up the figures in Table III. this all-important fact stands out clearly against the conditions prevailing in the older industries—that, of the total of the power sources now employed or shortly to be used for electro-chemical purposes, 378,000 h. p. are obtained from water, and only 40,350 from steam and 2,520 from gas-motors, of which latter 2,500 h. p. are natural gas. This fact merits the greatest attention in judging the economic efficiency of a country. The older industry, almost in its entirety, feeds upon stores which, however plentiful, are a part of a more or less completed period of development of our globe, for which no material replenishing can be expected. The electro-chemical industry, on the contrary, to the extent of 90 per cent., is dependent upon working energies which are given us daily, but which, were it not for the physico-chemical technologist, would as continuously pass away with the passing moment. Indeed, their only purpose up to the present time, appears to have been the restoration, sometimes in very radical manner, of the hydraulic equilibrium of the globe disturbed by the sun.

STANDARDISING IN ENGINEERING CONSTRUCTION.

By Sir Benjamin Browne.

III.—LABOUR'S INTEREST IN INDUSTRIAL REORGANISATION.



IN the introduction of standardisation into workshops where it has not hitherto been carried out—or, in fact, in any improvement of organisation or administration—to ensure success, it is necessary to have the hearty co-operation of the workmen themselves. It is all very well to say that an employer ought to be in a position to enforce his commands, to override opposition, and to insist on people doing what they are told; but everybody, who has thought at all on the question, must know that enforced obedience and unwilling service, even if secured (and it is by no means certain that they will be secured) are altogether a different thing from a cordial co-operation.

It has already been pointed out how necessary it is for the man who works a machine to have his whole heart and soul in the successful carrying out of these methods, and I tried to show, in the beginning of the second paper, that really a higher class of intelligence and character is required to carry out an elaborate organisation, than to make a single article of a first class quality by hand.

But how is this co-operation to be obtained? It is well known that there is a very large political party in England who hold very unsound views as to the interests of the working classes with reference to economy of production. Corresponding parties exercise more or less influence in other countries, though perhaps least of all in the United States of America. It is very often said by the leaders of the workmen that engineering manufactures are necessities, and that if a man wants a ship, and cannot buy it cheap, he must buy it dear—that, in other words, if only employers would stand firmly together to keep up prices, they might, perfectly well, not only pay the workmen higher wages, but make larger profits for themselves. Let them put up the prices of ships, engines, or machinery 20 per cent.; if they are all true to each other, it is said, the public will have to pay the price, and both the workman and manufacturer will be better off.

Now, we need hardly say that this teaching is as false as anything can possibly be. My only diffidence in putting it forward is, that those who have not actual experience may be slow to believe that any large number of men can be found believing such utter fallacies; and the worst is that these ideas are not confined to the working classes, but are held by a great many Socialist theorists in a higher position. Perhaps even employers themselves have hardly thought out to what an extent this teaching is false. The fact is that, taken as a whole, there are very few manufactures which are so sensitive on the question of price as engine work, ships, and machinery, and few that will be so readily dispensed with by would-be purchasers, if the prices are not such as to give them complete satisfaction.

The object of standardising work is to ensure a definite level of excellence at a diminished cost. The first point generally commands the approval of the workmen, but they by no means always sympathise with the second. Now, to investigate the position, and decide whether they are right or not, let us ask ourselves, as a question of political economy: Whence comes the fund that pays for our engineering manufactures? For it is obvious that, before we know what the public will pay for our products, we must know what funds they have at their disposal and who are our real competitors in the spending of that fund. Most engineering manufactures will fall into one of three classes. First, the material of war. In this, probably, cost is not a matter of vital importance. If countries need defence, it may be said that they must have it; and although, probably, the ultimate limit spent by any admiralty or war office on ships and armaments is measured by the amount of taxation the country will bear, still there is, no doubt, a certain amount of toughness in the demand; and if the government thought that they wanted three or four more line-of-battle ships, the question of cost would enter only slightly into their calculations.

Secondly, there are necessary repairs and renewals. When a railway is at work, the traffic must be kept going. This applies also to a line of steamers, to a factory, to a colliery, and to almost all going concerns. Very likely all the work that comes into this category would have to be ordered, notwithstanding an appreciable increase in the cost of it. But when you come to reckon up the work that is done by engineers, and that which finds them employment, it will be seen that the two classes just mentioned form only a comparatively small part of the whole, and that what really keeps our large works going, and finds employment for our workmen—above all, that which creates a real demand for their services—is what may be generally classed as "new commercial work." Into this class fall all extensions of our railways, all expansion in our fleets of steamers, all increases to our factories, workshops, mines, tramways, and the like; and the point to be observed in all these is, that nearly all the articles required for these purposes are simply purchased by the purchaser *for the purpose of making money.*

In other words, they are investments. If people make a new railway, or increase an old one, it is because they think the capital they so invest will pay larger dividends than they can get in any other available investment with equal security. If they put money into a steamer, that again is for the sake of the dividends; and so if they enlarge their factories, collieries, or anything else, it is all in order that the money so sunk may be to them a profitable investment.

Now, it does not need an employer or a specialist to know this. Any workman taking a superficial view of the work that is turned out in his district can satisfy himself on this point, viz.—that his business is to make dividend-paying appliances, and it is quite obvious that here there is no hard and fast rule as to what the world wants, or what it does not want.

Consider the case of railways. A capitalist finds that there would be sufficient traffic in a given district in Africa to bring in a revenue of £10,000 a year to a railway. About half that money would be required to work the line; the other half would be available for paying dividends. If he can make his railway for £100,000, the investors will receive at once 5 per cent. on their money, and this, coupled with the fact that they may fairly hope for future improvement, will very probably be sufficient to induce them to invest their money in this undertaking, and so to make large purchases of locomotive engines, rolling stock, rails, signals, and plant of various description, all of which gives work to the engineer at home.

But, suppose that these articles, and all the other matters that go to make the railway, increase on an average 25 per cent. in cost, so that instead of costing £100,000 the railway will cost £125,000; now where are we? The traffic is not thereby increased; the increased cost does not give the natives any more palm oil and ivory to sell, or any more blankets and hardware to buy. Therefore, there is still the same old £10,000 to divide as a return on the higher amount of capital. This means, in other words, that the proposed investor will only get 4 per cent. on his money, instead of 5, and he will probably say that, if this is the case, he had better invest his money in something else, and he will at once consider the merits of all the thousand-and-one investments that the stock exchange can offer him, besides the merits of farming, house building, and other things; and I think the conclusion we should arrive at is that, whereas at 5 per cent. the money would be forthcoming, at 4 per cent. it will not.

The more we look into engineering works, the more this fact will force itself upon us—that the engineer is paid out of money which somebody wants to invest—in other words, out of money which somebody has saved; and we can, with perfect truth, tell our workmen in any engine works or shipyard that their existence, as a class, depends not on the necessities of the human race, but on the money which rich men have accumulated after spending all they want to spend. This may be a discouraging view, as it often is a very irritating one; but it is quite impossible to shut one's eyes to the truth of it. Suppose, for the sake of argument, that money was more equally distributed than it is, and that a certain £100,000, instead of going into the pockets of a few capitalists, was divided over the incomes of a large number of workmen; let us see where this will land manufacturing engineers. The first effect would probably be that the workmen, or at any rate the best of them, would live in better houses, would buy better clothes, eat better food, buy more books, and in such ways they would make more trade for the people who provide these matters. In other words, this might be for the good of the farmer, the clothier, and the shopkeeper; but it would, at any rate at first, probably be in only a minority of cases that they would save the money with a view to investment. A certain amount of it would be saved, but very much less than if it went into the hands of capitalists, and what was saved would go largely into houses and furniture, and not into what we commonly mean by investments.

If a rich man suddenly gets a large amount of money, he may spend a certain amount of it, perhaps a few hundreds, on his pleasure, but he is nearly certain to invest the many thousands with a view to future permanent increase to his income.

Therefore, if this £100,000 goes to a few capitalists, a very large part of it will go to make employment for engineers and shipbuilders, whereas if it is divided up, to increase slightly the income of a large number of people who are not able at present to spend so much as they would like, the first effect would be that they would spend it on their comforts, and of this only a very small part indeed would go to make work for engineering establishments.

Of course, a small amount would do so. For example, if more meat is eaten, it may have to be imported, and more ships are required, but the demand this makes is infinitesmal compared to what the professional shipowner will do when he is beating up and working for trade in all directions for his own interest and profit, and I think I may fairly say that such bodies as are represented by the Amalgamated Society of Engineers, the Boilermakers' Society, and the other wealthy and influential unions connected with the engineering trade, would all be just about ruined, if we had a redistribution of property.

This may be a strong way of putting it, but it is based not on theory only, but on all experience; and there are so many people now who profess to be men of education and learning, but who mislead the working classes by socialistic writings, that it is quite time to put these matters plainly.

There is no more definite rule for the number of ships that sail on the Atlantic than there is for the number of cabs that can find work in the streets of London. Nobody can doubt that if cabs could be built a great deal cheaper, more cabs would be put on the road, and more work would be found for coachbuilders and their workmen. So it is with ships. A ship is nothing more than the packing case of the goods that come over in it. What the public wants is the cargo. What the shipowner wants is the profit on the carrying trade. Either of them wants the ship only as a means to these ends, and if ships can be built cheaper, the profit made by the shipowner is divided over a smaller amount of capital, and therefore there is a larger percentage; and, as regards the public, the cheaper the packing case, and the cheaper the mode of transit, the more are they able and willing to afford of the comfort or luxury obtainable from the cargo.

It is difficult to estimate to what extent a diminution in price will cause an increase in trade, but we have pointed out how many investments might be annihilated by a 25 per cent. increase in price, so we may fairly infer that if we could make a 25 per cent. reduction in price we should increase our trade very largely indeed.

Of course, the time may be coming, when the working classes will save more rigorously and invest more systematically; when they do, it will matter less to engineers which way the money goes, and the men who save will, to that extent, be members of the middle class, and will have taken a long step to efface the boundary that separates them from their employers.

It must be borne in mind that a very great deal of English capital is invested in engine and other manufacturering works in foreign countries, and the object of the manufacturing engineer, as a patriot, should be to try and keep this money at home. This can be done only by making the home investments more profitable, and the way we can most often do this, as has been already pointed out, is by reducing the cost, and therefore the capital, over which the money earned in dividend has to be divided.

If what I have said is correct, it will be seen that disputes as to wages between employers and workmen are of very much less importance than questions as to restrictions of trade and management of works. Supposing half the cost of an engine consisted of the engineers' wages (and, generally speaking, it is less than this), a 5 per cent. rise or fall would only mean 2½ per cent. on the cost, whereas methods or policies which make men work in a less efficient manner may double, or treble, the cost of labour. The settlement of questions as to the difference between piece and time work, of the questions of a greater number of machines being worked by one man, and still more important, of the question of substituting machine for hand labour—these, and numberless other matters that are often in dispute in English workshops, are therefore far more vital than mere rates of wages.

It is probably the case that, if the workmen could see their way to throw themselves heart and soul into the views of the employers in trying to economise the cost of work, they could get, with little or no trouble, a very large increase in their wages, make very much larger incomes, and have much more permanent work, with employment for a much greater number.

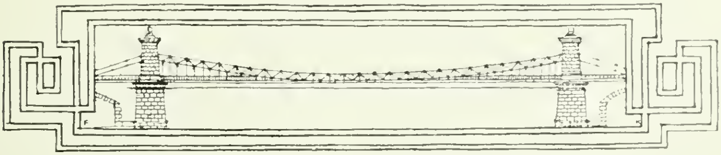
It is not fair to put the question of restriction down to trades unionism. The fault is in human nature, and we find it frequently among both classes and individuals who have never been connected with trades unions in their lives. Of course, the obvious effect of the trades unions is to cause the opinion of the majority to influence the minority more quickly than it would do otherwise, and where the opinion of the majority is wrong, this, of course, is a great pity; but, on the other hand, the unions must be credited with the abolition of many faults and vices which might otherwise still hold their own and flourish among considerable minorities of the community. The fault of trades unions, as of all other associations of human beings, is that they are inclined to be too despotic and to press their opinions too hard. It is possibly quite right and natural that men should combine and act together, but they ought to leave a fair margin for individual enterprise and individual experiment, among workmen as among capitalists. If a man is pursuing a suicidal policy, they would often gain more by letting the experiment be tried out without interruption than by stopping it arbitrarily.

The same arguments that apply against workmen's unions, and all dangers that appertain to them, are liable to apply quite as fully against the employers' unions, whenever these come to be permanently established; and there is no doubt they are gaining in strength throughout the United Kingdom every day. The joint regulations that are made between employers, as a whole, and the men, as a whole, frequently hinder an ingenious employer, or an enterprising workman, from trying something which he believes would be a success, and they certainly tend to stagnate and crystallise the customs of the trade and to destroy individuality. In so far as unions do this, they are, indeed, a hindrance to the development of the trade of the country; but if they were more enlightened and worked with more elasticity, it is difficult to say that they would do more harm than is done by that public opinion which exists in every community, and which so few men of any class or rank are really prepared to defy.

Standardising is, after all, one only of many ways of improving workshop economy; but it is a very important one, and no engineer in charge of works can consider that he has done his duty till he has studied the question carefully and carried it out as far as is possible.

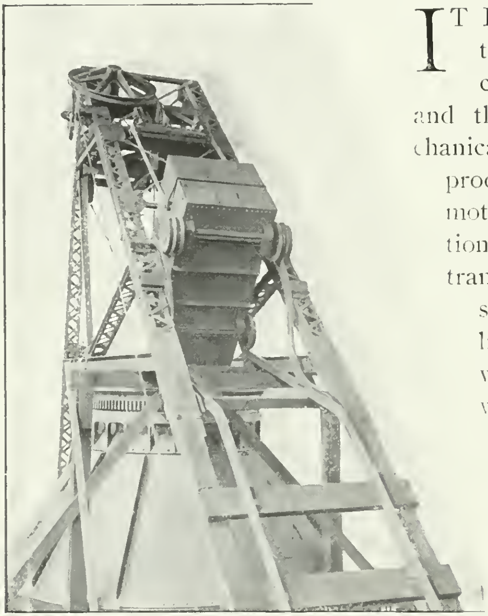
The readers of these papers may feel that, while much has been said as to the need of standardisation, comparatively little has been said as to its technical adoption. But that is exactly the vital point. Let its value be once recognised and its adoption desired, and no engineer will have any difficulty in finding out how to do it. The introduction must, like any other improvement, be somewhat gradual, and while each step is taken the next can be learned.

But, above everything, the improvement we most of all need is a hearty spirit of co-operation between workmen and employers. If we could bring this about, we should have no fear of foreign competition, and very little of bad trade.



MECHANICAL TRANSPORT APPLIANCES IN ENGINEERING WORK.

By A. J. S. B. Little.



A MECHANICAL FURNACE-FILLER.
Brown Hoisting and Conveying Machine Co.

IT IS axiomatic to repeat that the whole of industrial work consists in moving matter and that the advantage of mechanical appliances consists in the production and disposition of motive power; yet the introduction of automatic material-transmitters has been painfully slow in engineering establishments, and in other places where work is carried on and where materials have to be moved in their crude and finished states; yet power can be applied through machinery designed to economically convey, elevate, and distribute in every conceivable direction, with a reduced expenditure of money by the capitalist and of physical energy by the labourer. Despite the importance of labourlessly handling products, the means of accomplishing the desired end are imperfectly understood, and we must reluctantly confess that in Great Britain this fault is especially noticeable. We raise about 200,000,000 tons of coal a year (202,000,000 in 1897), which is shifted, say, three times before being consumed, making an equivalent movement of 600,000,000 tons of coal at cost of about 6d. a ton by hand and 1d. a ton by machinery; still only a small percentage of this coal is mechanically moved, the proprietors and managers who have the necessary powers being unaccountably conservative in abiding by the primitive methods which call for the use of barrow and

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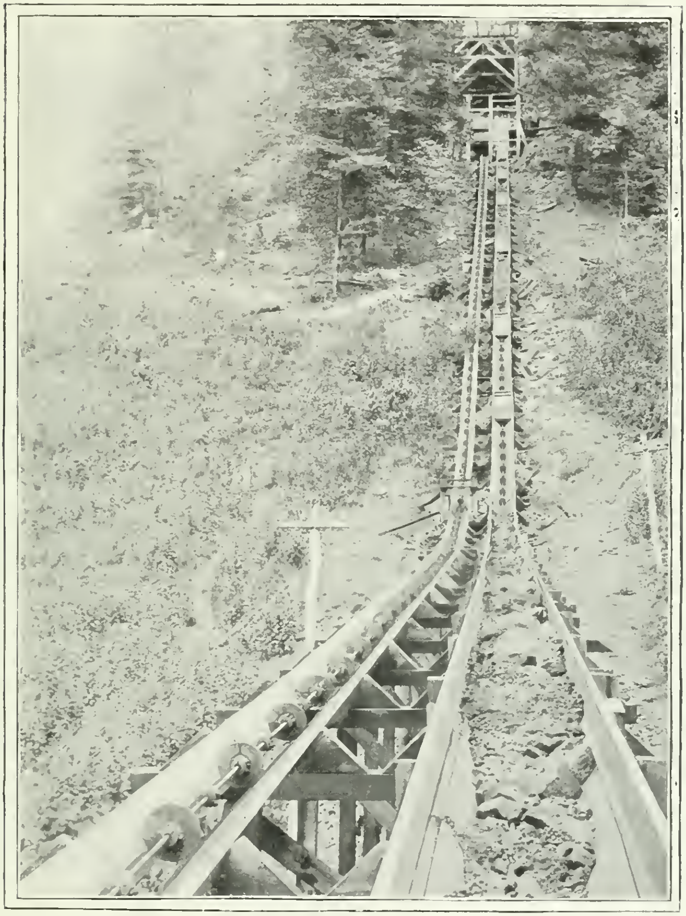
Engineering has been defined as the application of forces to the removal of materials. The limitation of any given undertaking is that of the cost which the results will justify. Mr. Roland, elsewhere in these pages, tells of the skill of the mechanical engineer in



RETARDING COAL-CONVEYING PLANT, LOGAN CONSOLIDATED COAL CO., MATEWAN, WEST VA.

The wire cable with attachments, operating over sheaves at top and bottom, replaces the tram system. It lowers run-of-mine coal, without breakage, over a distance of 550 ft., in a continuous stream, at the rate of 1,500 tons in 10 hrs. By the Jeffrey Mfg. Co.

shovel and concomitant waste of labour. Many reasons might be cited in explanation of this suicidal conduct, the main ones being want of capital at the disposal of proprietors, who are fraternally helped in their destruction by the inexperience, lethargy, or ignorance of the

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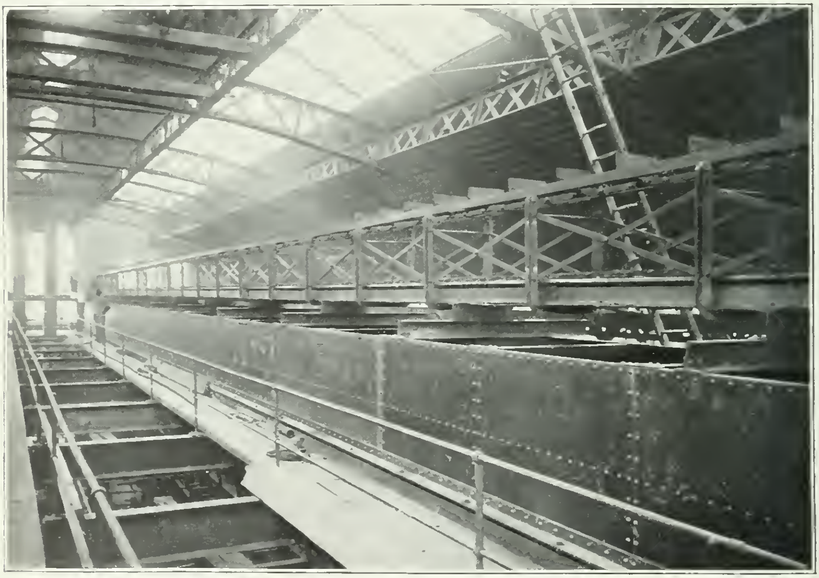
cheapening and quickening mechanical manufacture. Mr. Little, in this paper and a succeeding one, shows how similar patient genius and concentration of study have enormously increased the power and lightened the labour of great engineering works—civil, municipal, mining, metallurgical—in fact, the entire range of constructive, manufacturing, and industrial effort. The field is so vast and varied that much must be told by illustration rather than by text.—THE EDITORS.

working counsellors responsible for the healthful preservation of the firm's commercial life.

In handling coal from pit cages, the first operation is to size and clean it. This is best done mechanically with the aid of power-driven tipplers, fixed, jigging, revolving, and oscillating bar screens, picking tables where the splint is removed and the best coal delivered to trucks on railways, and conveyors to remove the small coal and deposit it in trucks on other lines of rails. Dirt conveyors may be placed collaterally or transversely with main belts, to take the slate and dirt to trucks, and, where smudge from coal washers is not available, a conveyor may be used to feed small coal to stoker hoppers.

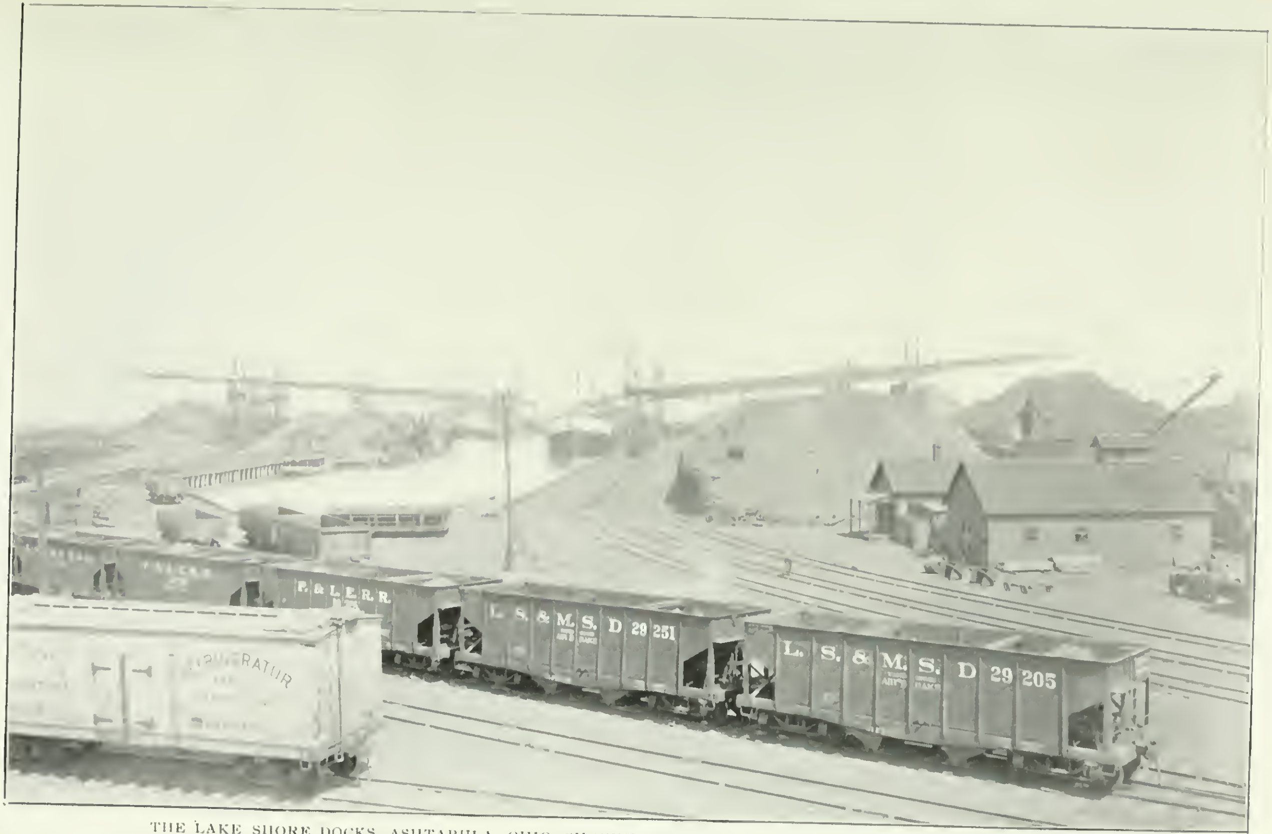


PUSH-PLATE CONVEYORS HANDLING COAL TO STORAGE.

The installation in the gas works of the Huddersfield Corporation has been in service more than six years, and is still in daily use. By the New Conveyor Co.

When collieries have a coal-washing plant in their vicinity a progeny in the form of a battery of coke ovens is sometimes the result of the successful union; in other cases it is found more profitable to work the ovens in juxtaposition to steel works. Experience proves that prosperity follows when labour-saving plant is introduced to feed the ovens, because the existing conditions are especially favourable to its adoption, the work being regular and sufficiently large to pay interest on a large capital expenditure.

The coal from the large storage hoppers is automatically fed by



THE LAKE SHORE DOCKS, ASHTABULA, OHIO, SHOWING ORE- AND COAL-HANDLING AND STORAGE PLANT.
The bridges are of 180-ft. span, 90-ft. cantilevers. The capacity is 50 tons per hour for each bridge. Brown Hoisting & Conveying Machine Co.

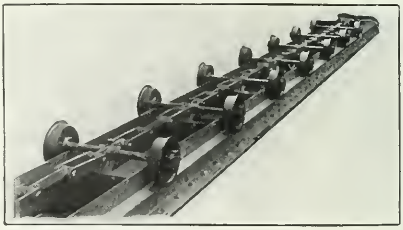
CONVEYING PLANT FOR COAL AND COKE

Two elevators, side-by-side on the left, lift coal to storage. The elevator on the right lifts coke to trucks. New Conveyor Co , Ld.

soles tournants to a conveyor extending to the disintegrator, from which, in turn, the pulverised coal is fed to the bucket-elevator feeding conveyors over the second battery of hoppers at the end of coke ovens; small tipping trucks passing underneath take the material to the ovens; conveyors are also applicable for taking away the coke and raising it to a height from whence it can be shot into hoppers or waggons, as is done by the plant at the Carlton Iron Company's ovens.

Gas producers call for the free use of transport appliances. The most favoured method of charging them is by the aid of scraper conveyors and elevators feeding storage hoppers, while the ash can be removed to hoppers in the same manner.

To give an idea of the flexibility of these labour-saving appliances, which are to be seen working in all industrial establishments, we may say it is difficult for an engineer, who is *au fait* with the designs of machinery for efficiently handling materials and products, to imagine a situation where goods are being shifted, in which the operation cannot be performed by mechanical appliances. In the mineral centres engineers on the lookout for some system to ensure the regular working of their plant scheme to introduce a method of feeding the ore stamps, talc mills, coal trucks, brick-making machines, cyanide hoppers, lime screens, iron and other ore-carrying trucks and boats, caliche and calcined-ore hoppers, or whatever the particular requirements may call for; the miller charges his threshers and fills his sacks, or sends his grain in bulk to the enormous silos, where it is automatically stored and labourlessly picked up again for distribution to malt houses; there it is carried to cisterns, lifted into kilns, and afterwards carted to the breweries; there

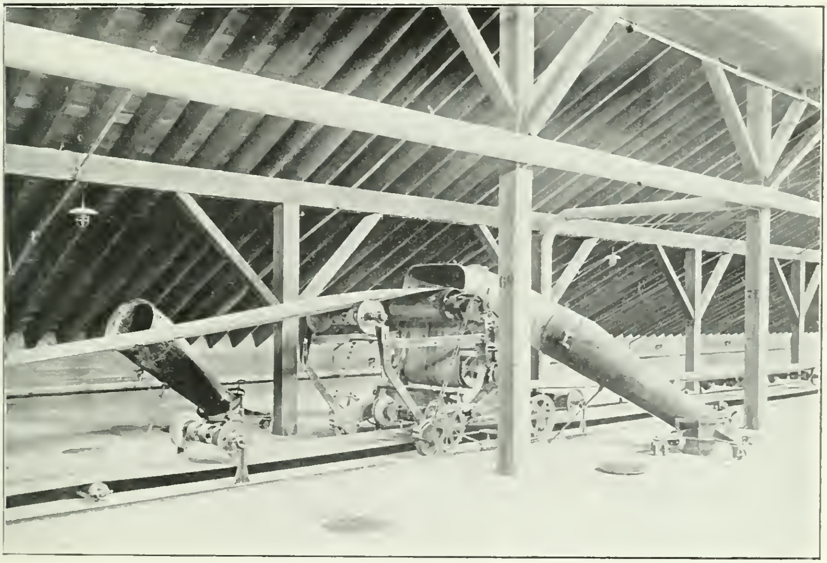


COMBINATION ROLLER AND SCRAPER CONVEYOR.

The scrapers have clearance at bottom and sides, and are carried by rollers outside the trough, thus avoiding noise. By Blake, Barclay & Co.

again it is transported and lifted, time after time, on its journey through the mash tuns and into the wet-grain tanks.

Candidates for municipal honours advocate destructors to get rid of garbage and other refuse, and, inasmuch as the one erected at Shoreditch is an improvement on the old sewage farm, so the feeding of the furnaces by elevators with 36-inch-wide buckets reduces the cost of handling materials and performs automatically what is otherwise a nasty labourious job. Take a look in at a gas works where the retorts are stoked by hand labour, and then visit a bench designed on the inclined principle, charged from overhead tanks filled by elevating and conveying machinery. In the former works the men have to weigh or measure the charge, wheel it to the retort mouth, shovel in the coal—and it is a difficult matter to ensure the even charging so necessary to obtain perfect carbonisation—then, after carbonisation they must rake out the coke and slake it preparatory to wheeling it to yard. Then the men hang their shirts up to dry. In the mechanically-equipped house, with a clear retort, the men close the bottom lid, pull a lever to open a measuring chamber and then shut the top lid. The machinery has already filled the tanks and measuring chambers holding about 7 cwt. of coal. After carbonisation the coke *slides*



BELT CONVEYOR IN A GRAIN WAREHOUSE.

Manchester elevators. The tripping arrangement shown in position delivers the grain to any bin. Capacity, 5,000 bushels an hour. Webster Manufacturing Co.

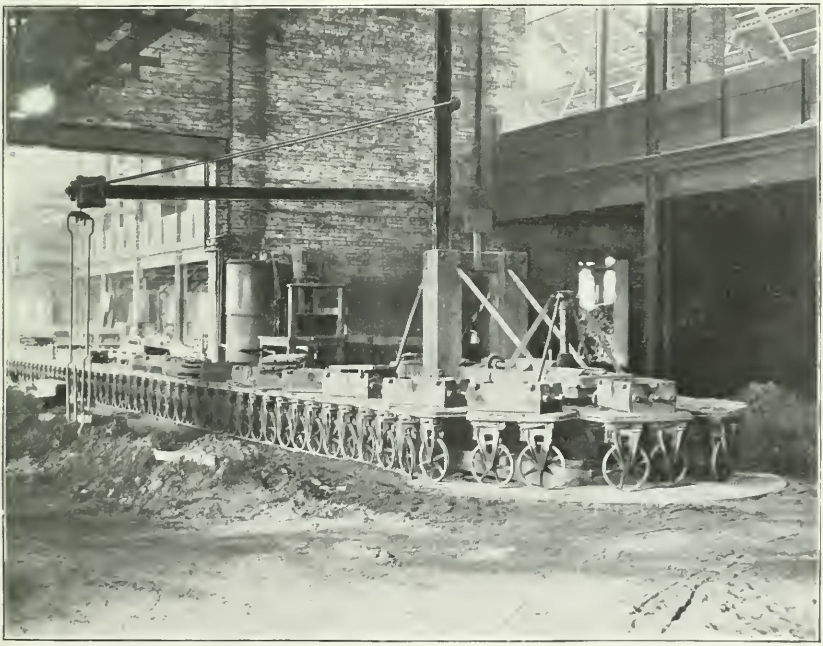
CONVEYORS FEEDING COAL TO BUNKERS OVER INCLINED RETORTS, MEADOW LANE GAS WORKS, LEEDS.

A similar installation is being put up to same designs at York Road, Leeds. The New Conveyor Co., Ld.

out of the retort onto a patent slaking conveyor which delivers into an elevator feeding a conveyor in yard. In the yard the coke is automatically screened, stored, measured or weighed, carted, trucked or bagged; apart from the saving in labour, the coke is more carefully handled, reducing breakage to a minimum and ensuring better selling prices. The workmen certainly score on this job and the company or corporation benefit by a saving of 1s. to 2s. per ton of coal carbonised.

In iron works, conveyors are now made use of to cast pigs at a reduced cost. This method makes it possible to tap furnaces at such times as may be found convenient, and ensures smooth and clean pigs of a uniform size and quality, and more homogeneous than those obtained by the older practice. The travelling moulds, made of ordinary Bessemer-iron castings, are connected to a double strand of chains; the iron is poured from the hot-metal ladles directly into a pot, which conveys the molten metal to, and distributes it over, the strands of moving moulds. Each strand consists of about two hundred and sixty moulds, and is about 125 ft. long. The moulds travel upwards on an incline of 9°, and are carried over sprocket wheels. The time taken to traverse the distance by any particular mould is about ten minutes. During this time the iron has solidified, and as they travel over the end the pigs are precipitated down two shoots, leading to a tank about 60 ft. long which contains just sufficient water to cover them. The pigs are carried through the tank on a conveyor, which, at the end of the tank, is carried around sprocket wheels, over which the pigs are precipitated into two shoots, discharging them directly into the waggons. Thus, unless for stocking, the pigs are never handled. With successive casts passing over the machine, the moulds are kept at a low red heat. To prevent the molten metal adhering to the moulds, they are coated with a refractory material on the return journey to the pouring pot by means of an ingenious spraying apparatus. A plant of this description on the Uehling system is working at the Millom and Askham Hematite Iron Co.'s works, and a number of similar machines have been long installed on the European and American continents.

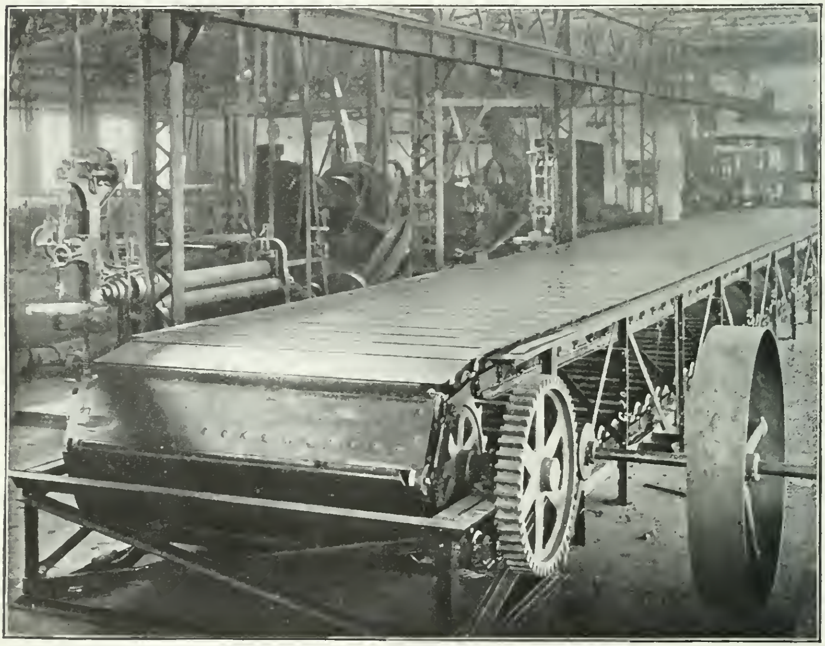
In the November, 1897, impression of this magazine some useful figures were given relating to cost of operating wharf plants; to those who are specially interested in this class of work I would only add



FLASK CONVEYOR IN THE WESTINGHOUSE AIR-BRAKE COMPANY'S FOUNDRY.
The plant is at at Wilmerding, Pa., and is used in connection with moulding machine and cupola. Flasks from the machine are placed in the carrier, 225 ft. long, conveyed to the cupola for pouring, and, cooling in transit, are shaken out at farther end of the foundry. Link-Belt Engineering Co.

that the Ardrossan harbour in Scotland boasts some good machinery for loading and unloading sea-going vessels, on six or seven different principles, including a good railway-truck tilting arrangement.

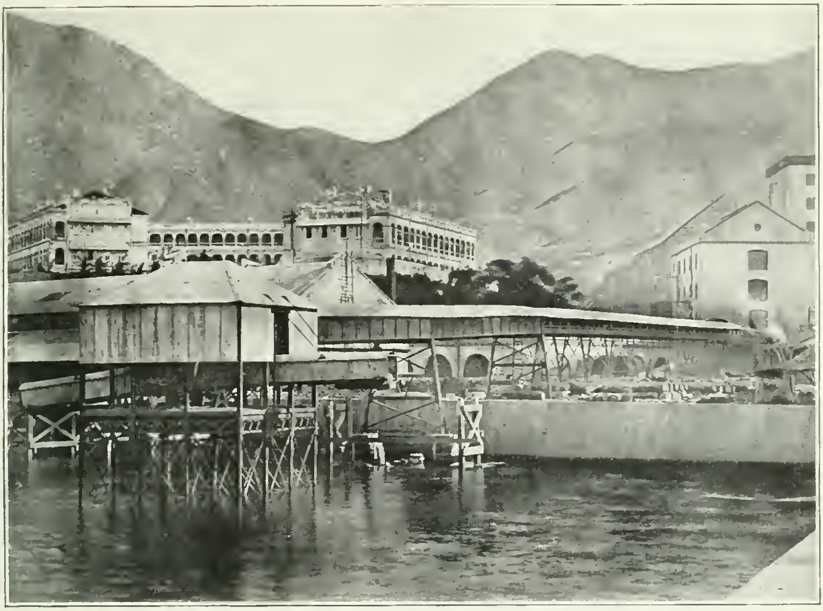
The Woolwich Arsenal has a plant for handling wood chips used in the manufacture of acetylene, and at a works in proximity to London conveyors are used to carry boxes through a heated chamber, wherein the labels on them are dried; a totally different system is in operation in India to dry small coal which traverses a trough fitted with spiral conveyor built over brick furnaces. The Roburite Explosives Co. use a similar conveyor made with a jacketed trough to which live steam is supplied and thus the material is conveyed and dried; almost any material could be similarly treated. Paper pulp is automatically conveyed at Townsend Hook & Co.'s works, while Bazley White & Co. have utilised tray conveyors to feed cement crushers, and manage to pick out clinker from cement on its way to mill.



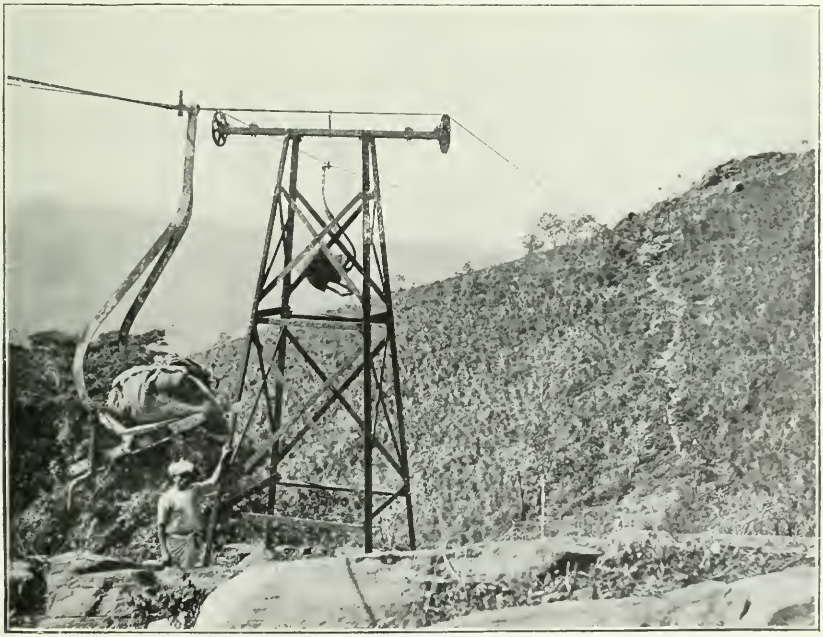
CONVEYOR FOR KEEPING STRAIGHT THE STRAP IRON FROM THE ROLLS

In use by the Union Iron & Steel Co., Youngstown, Ohio. The carrier is 106 ft. long and 6 ft. wide. Machines of like design are used as picking bands at coal-breakers, for which service they are run from 10 to 30 ft. per minute. Link-Belt Engineering Co.

At St. Helens elevators are being erected to feed refuse to the furnaces put up by the Beaman and Deas Syndicate, the

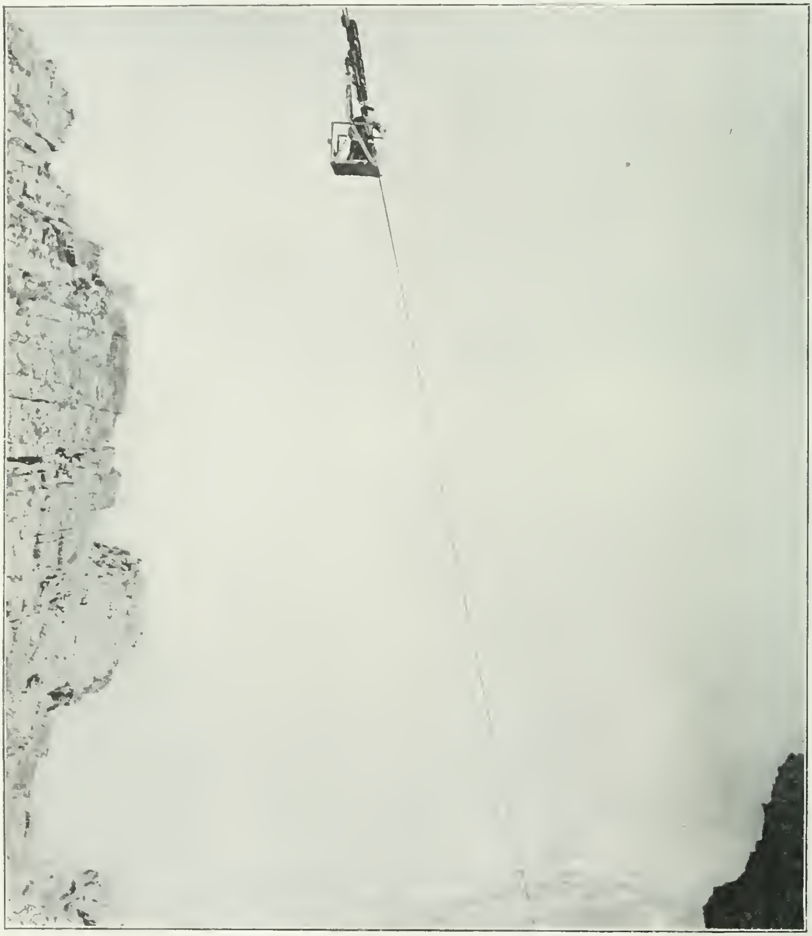


CONVEYOR FOR LOADING REFINED SUGAR INTO SHIPPING-OFF BARGES.
At work in the East. Made by Blake, Barclay & Co.



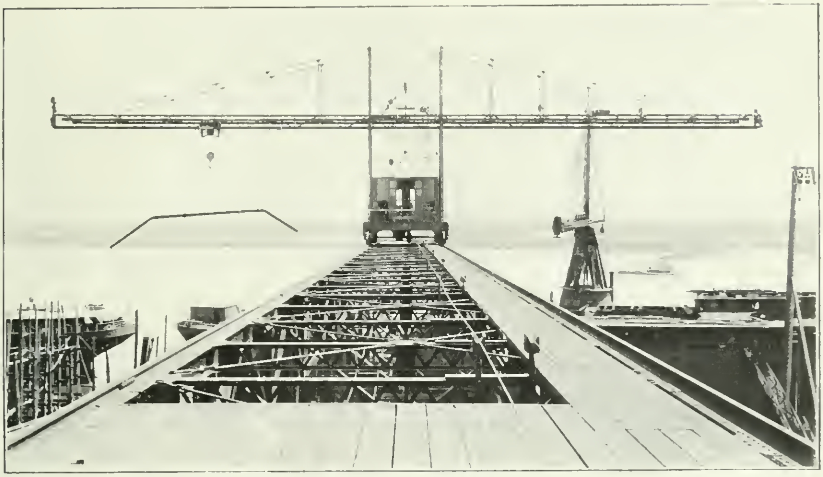
A ROPEWAY IN CEYLON.
The ropeway is three miles long, and is used for handling tea leaf. Bullivant & Co

buckets being 36″ wide and made to handle tin cans, mats, or any of the miscellaneous articles met with in the track of the night-soil man. Similar work is in progress for Aston, Birmingham and Hull, and it is certain that, apart from the money saved in capital outlay through the omission of inclined roadway and other adjuncts to the cart-tipping idea, a big annual profit will be secured to the undertaking on the resulting labour economy.



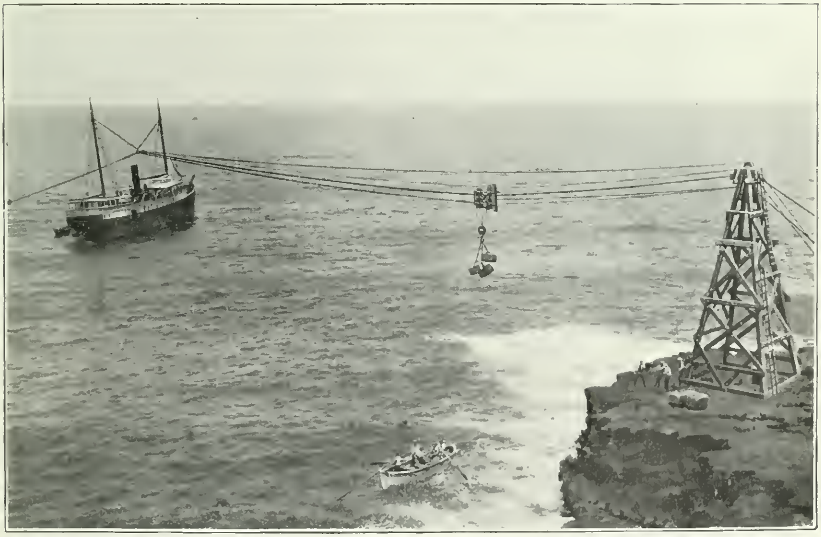
LONG SPAN OF THE CAPE TOWN ROPEWAY.
The seashore, wnere the distant terminal is situated, is seen at the bottom of the picture.
This ropeway was installed by Bullivant & Co.

Most engineers concede that by the aid of automatic transport machinery, applied to works other than their own, enormous reduc-



TRANSPORTING CRANE IN CRAMP'S SHIP-BUILDING YARD, PHILA., PA.
Two more similar battle-ship cranes are under erection. The span is 202 ft. over all, the longitudinal travel 547 ft. over all. The speed of the entire crane with load is 600 ft. per minute, of the hoist with full load 250 ft. per minute.
By Brown Hoisting and Conveying Machine Co.

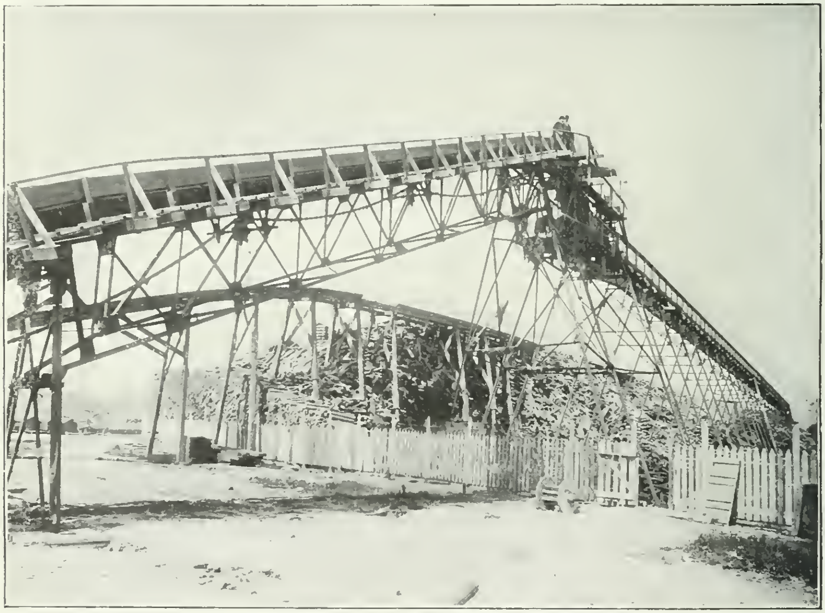
tions can be made in the cost of handling raw products, in the process of elaborating them into finished goods, and in the final distribution to points of consumption; but the harbouring by them of an idea



METHOD OF LOADING AND UNLOADING VESSELS FROM THE SHORE.
For use where rough seas, shelving shores, or infrequent business make piers undesirable. The main cable is permanently fixed to anchored buoy. Lidgerwood Mfg Co.

concerning introduction of improved methods in the works under their management is found fatiguing. A stranger, walking through works and being familiar with installations of conveying machinery, notices situations which are peculiarly adapted to the introduction of such machinery, while the man in charge, having worked his system for years, considers it perfect. His first argument against reconstruction is "capital expenditure" and he erroneously concludes that a big outlay is needed. Secondly, he discourses on the inability to handle his material, ending by the stereotyped remark "You know it is a different thing handling this gritty and large stuff to shifting grain."

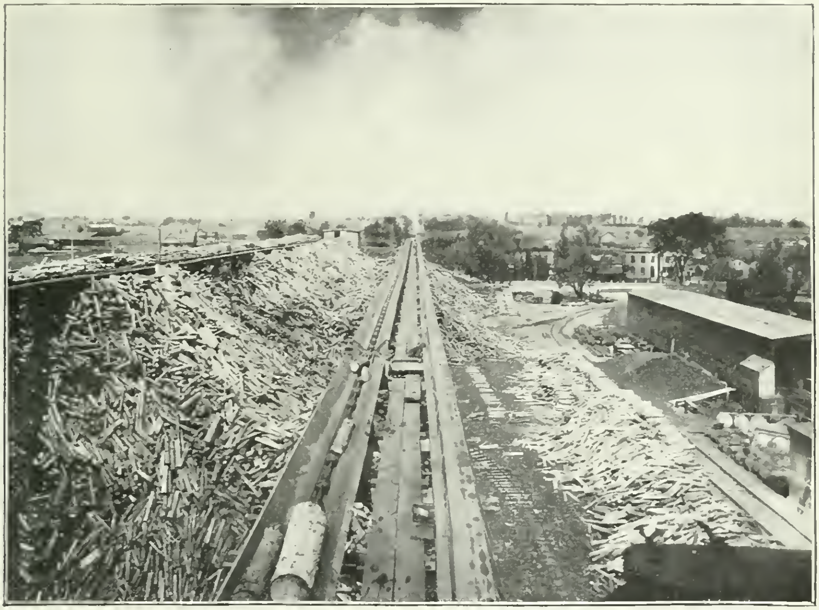
It may be surprising, but nevertheless is true, that for one plant designed to handle cereals automatically, hundreds have been adopted to work on minerals. In the chemical trade, for instance, plate belt conveyors and elevators are universally used; one plant alone comprises fourteen elevators and conveyors, having an aggregate length of 1,500 ft., to handle phosphate rock brought in ships to quay side, conveyed to stores, and thence taken to mills and deposited into hop-



PULP-WOOD CARRIER AT THE INTERNATIONAL PAPER COMPANY'S WORKS, NIAGARA FALLS, N. Y.

The chain carrier in the foreground carries the wood from the water 150 ft. to the 500-ft. wire-cable conveyor which delivers it to storage. The mills, which are among the largest in the world, thus store during the season enough wood to carry them over the winter. By the Jeffrey Manufacturing Co.

pers. Hundreds of small elevators are to be seen in the works of the United Alkali Co. and also in those of Brunner, Mond & Co., the Anglo-Continental Guano Co., and other large companies, while the smaller makers follow in their steps and dispense with the barrow and shovel as far as possible.



A VIEW OF THE WIRE-CABLE CONVEYOR DELIVERING PULP WOOD IN THE STORAGE YARDS OF THE INTERNATIONAL PAPER CO., NIAGARA FALLS, N. Y.

Steel works are well adapted to similar plant; here is it used principally for conveying coal, removing ash, elevating stone, carrying basic slag, etc. Hickmans Limited have a very complete plant for handling this last mentioned product, having erected separate buildings and fitted them with band-and-tray conveyors and elevators, which take the slag from the mill to the disintegrators; thence it is discharged through pipes to sacks situated over weighing machines. The only labour required is that necessary to tip the slag into the mill, and to tie up the sacks.

In the manufacture of screws and bolts, rivets, etc., the furnaces are fed with slack, the finished articles are removed to stores, and the swarf is taken from the sawdust with the aid of mechanical transporters. An arrangement in use at Miller & Co.'s works at Coatbridge feeds twenty-two rivet-heating furnaces, which heat the bars for forty rivet-making machines of an automatic type. The rivets are

CABLE TRANSPORTER IN DAM BUILDING.
Filling in a steel dam, Southern California Water Company, San Diego, Cal. 60 ft. depth of water. Lidgerwood Manufacturing Co.

made incredibly quickly. Coal is shot from waggons into elevators at 2½d. a ton, and the furnaces are worked by three men whose wages are 25s. a week, the conveyors being attended to by the man who oils the rivet machines. The conveying plant cost £700, and the cost of upkeep will be about £10 a year. The system gives entire satisfaction to the users, although it might be improved if an automatic truck-tipper were installed to empty coal automatically.

In the next issue of the Magazine I shall take up further applications of mechanical transport in the coal, iron, and steel industries, and the more distant carriage of materials by cableways.

TRANSPORTING CONCRETE FOR A NEW JERSEY DAM.
The cableway was used only for the concrete core. Lidgerwood Manufacturing Co.

THE STEAM ENGINE FOR THE ELECTRIC-TRACTION POWER-HOUSE.

By Charles Arthur Hague.

I.--PECULIAR PROBLEMS IMPOSED BY THE SUBTLE AND HIGHLY-VARIABLE LOAD.

THE rapid increase in the size and capacity of steam engine units for electric-power stations, until the ten-thousand horse-power mark is coming into sight—and indeed may be passed within a short time—illustrates, from a most searching point of view, the tremendous development of cities and towns, and the growth of the transportation problems involved therewith. Of course, the idea of large units carries with it the supplementary idea of enormous power-plants in the aggregate, until it has come to pass that the technical mind quite readily takes in and assimilates such items as 70,000 or even 100,000 i. h. p. under a single roof.

Nor is the mere size to which the steam-electric unit has attained the only striking feature of the matter. Seven or eight years ago, what is now known as the direct-connected dynamo had come into but limited use upon any scale at all, to say nothing of large capacities. Counter-shafting, belting, friction clutches, etc., were the thing; and a plant containing five or six 1,000- or 1,500-h. p. engines was a leader among its fellows, and not often to be seen. But with the gradual introduction of the dynamo mounted directly in connection with the main or crank shaft, the units could be increased with convenience and economy of space, to almost any desired extent. To-day, the three-phase alternating system of generating electric energy under high tension can no doubt be carried fully up to the limit represented by 10,000 h. p. in a single unit, by an appropriate arrangement of steam cylinders and crank shafts.

Probably there has never been known, for the steam engine, work of so variable a character as that of developing and furnishing power for a street railway; and when we get to operating what are now "steam roads" by electricity, making comparatively long runs on heavy tracks on solid road beds, the variable load represented by the passengers will be found to be much less, in proportion to the fixed load

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Great advances in engineering come at times by some sudden epoch-making discovery, but more often by the patient genius of close concentration upon the conditions of a problem of work to be accomplished. Few, outside of the limited circle of those directly represented by the cars themselves, than is the case in street-railway traffic.

In selecting a type of engine for street-railway work the extreme variation of load is a factor of great importance, and the choice must fall upon that type of engine which, under all of the conditions embraced in power-house demands, yields the best all-around economy in the long run and from the investors' standpoint. With steam engines, the higher the type with reference to multiple expansion the nearer generally must the most suitable conditions be followed. With a plain slide-valve engine controlled by a throttling governor, the widest range of work will affect the steam economy but slightly, if at all. With an automatic non-condensing engine, the lines must be regarded a little more carefully than with the plain slide valve, for best results. With the automatic simple condensing engine, with the exposure of the piston and cylinder walls to the low temperature of the exhaust, a wide range of duty still further interferes with economy of steam. With the compounds, and then up to the triples, quadruples, and to any higher plane of multiple cylinders, it will be found that the expected and promised economy due to the limited range of cylinder temperatures (obtained by cutting up into parts the complete expansion-diagram) can not be closely realized except by keeping nearly to ideal conditions for the particular type in hand.

The steam consumption of different types of engine is a subject of very great interest and importance; and when the range and variety in the service of different railroads can be made to point out, with fair accuracy, the type of engine best adapted to any case arising, then can the results of the adoption of this or that type and size of engine be foreseen. In a railway power-plant, the importance of looking into the value of an engine as an investment is greatly enhanced, of course, for the very reason that the conditions are complicated by the variations of load. The choice lies somewhere between a naturally-wasteful engine, whose economy can not be easily injured, and a very economical type of engine whose best economy can not be

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concerned in the results, realise the enormous difficulties imposed by the traction power-house, nor the triumphant manner in which they have been met and surmounted by the engineers and builders who have devoted their efforts to this special problem. American practice has been peculiarly fruitful of opportunity for study of this question, and is rich in its fund of practical experience. A summary of the conclusions is of the utmost interest and value to everyone interested in the extension of electric traction. We are gratified at being able to present so authoritative a review as Mr. Hague's, and at thus falling into accord with modern engineering development by placing the stores of accumulated experience at the command of those who are making further progress. It is highly interesting, in this connection, to compare Herr Friese's paper on German practice and Prof. Carpenter's on American engine economy, reviewed respectively on pages 441 and 452 of this issue.—The Editors.

maintained at all. This choice seems to point to the cross-compound condensing engine for units of 1,000 h. p. and upwards.

The variations in the power demands of street-railway work, as compared with the operation of an engine driving a flouring mill or under other steady demands securing practically the best conditions, are reflected in the difference in steam consumption probably about as follows for different types of engine, that for the steady load being taken at 100.

Type of Engine.	Steady Load.	Power-House.
Simple non-condensing	100	130
Simple condensing	100	145
Cross-compound condensing	100	125
Triple condensing	100	150

The cross compound does not seem quite to bear out the idea already set forth—of disturbed efficiency in relation to type; but the departure is favorable to the engine and its good results in power-house work are probably due to the fact that the cross compound is, practically, a simple non-condensing automatic engine at one side, working under good conditions in the main, in conjunction with a simple condensing engine having the advantage of a low range of temperature in its cylinder—making a happy combination of powers, loads, and temperatures, fairly consistent with the quickly and widely varying demands—especially if automatic regulation is employed with the cut-off valves for both sides of the engine. The question is sometimes raised of storage batteries and triple-expansion engines in connection therewith, permitting steady and constant operation of the engines at their best economical point; but so far the interest account, maintenance, and shrinkage of output, together with some tardiness in sudden and great discharges, called for at times during rush hours, seem to render those cautious who would become responsible for the installation of such batteries in large plants for furnishing railway power. Cheap money and dear fuel, together with some other items of more or less importance, are the friends of the storage battery most likely to force a readjustment of conditions, and perhaps to lead in the future to a partial sacrifice of some items just now held to be of greater importance in the general make up of the power-house account.

The adaptation of means to ends, where the means have consisted of all known types of steam engines, and the ends desired have been a practically uniform voltage under all changes of quantity, seems to have resulted in the choice, for large units, of the cross-compound vertical condensing engine; and this seems to be the common goal of the engine builder in making sure of what he can accomplish with reasonable certainty, and also of the chief engineer, or manager or superintendent of the railway, in recognizing the best he can probably do under all of the conditions involved. This, of course, may be all changed in the future; but at present the matter of variable load seems to be the stumbling-block in the way of multiple expansion—especially so quickly sensitive and subtle a load as this. As the powers increase, more cylinders than two will have to be employed, even with the vertical engines; it is conceivable that eight cylinders may be used with a quarter-crank engine producing 15,000 h. p. in a single unit and still retain the compound engine. The trouble with the load varying from "all off" to 50 per cent. overload, is not so much with the total range of the expansion as with letting go of the steam too many times in passing and using it through several cylinders in a series; the compound simply taking it in giving it one squeeze and then passing it to another cylinder, squeezing it again and sending it to the condenser. This keeps the load close to the team, so to speak.

The question of speed or voltage regulation has been a source of anxiety to engine builders and electrical-power engineers; the secret seems to be, as much as anything, to have the engine well in hand and under close limits of control—or, in other words, to drive the team with moderately taut reins after harnessing it rather closely to the load. The combination of throttling and cut-off regulation promises something in this direction; but perhaps the haunting spectre of "close regulation" of speed has kept back something better. If what is wanted in supplying the current is a uniform voltage, combined with a variable flow, perhaps the exacting requirements so often held to are not, after all, the real requisite. Every water-works manager, dealing with the supply of water through pipes, would have, if he could get it, absolute uniformity of pressure with the quantity varying to suit the demand; this would call for just the opposite to uniformity of speed, because uniform speed in a pumping engine would give constant quantity and variable pressure. So, with a constant voltage and a varying product of volts and amperes, what is wanted is the engine which will preserve the balance—even if we do have to overcome our habit of thinking about cotton-mill spindles and flour-mill rollers, picks to the inch and pounds to the bushel. The work of the cotton mill is 1,000 spindles or 5,000 spindles at uniform speed for the uniform spinning, the variation of power being due to the variation in the number of spindles. But the cotton mill was with us first and had wedded together uniformity of speed and variableness of power to an extent which makes necessary an effort in the breaking away from it. But conservatism commits less errors than radicalism, so we must get a fairly good hold of one rope before we let go of a well-tried one. But it may be that correct voltage will be a better term than constant voltage; in any event, why not regulate the engine with the proper voltage in view, and regulate by the voltage itself, regardless of speed?

Still another legacy, from a different steam-engine practice, is the absolutism of demand for a perfect indicator card. In sheer despair at our efforts to retain the immaculate diagram, we will some day make a concession at the best point of compromise and suddenly wake up to the fact that we are more strictly scientific than ever before in obtaining control and regulation of the steam engine. In fact, the practice of throttling the initial steam for very short cut-off and, in combination therewith, varying the point of cut-off further out in the stroke with the full initial, has already entered the field; and this line of action, to which the steam engineer has been driven against his stubborn will, may possibly open the door for a longer line of multiple expansion under greatly variable loads. Some time ago I became interested in investigating the propulsion lines of a proposed triple-expansion engine for electrical-power development, and, after various experiments, followed the line of throttling the "peak" of the high-pressure diagram; regulating the cut-off automatically on the intermediate cylinder and having a fixed cut-off pretty well out on the low pressure. The resulting development of propulsion, under widely variable loads, was a strong appeal for the triple engine in power-plants—with apparent promise of holding the variation in steam consumption within the lines of the compound and, at the same time, giving a higher actual steam economy. This idea, carried out on large engines, would give twelve impulses per revolution and an angular velocity of the revolving fields closely approaching uniformity.

After we have been forced to make a concession to laws of nature which, at first, were not recognized, it is generally found that the inexorable facts in the situation were merely asserting themselves for the consistency and betterment of the scheme in hand. This, applied to the combination of throttling and automatic-regulating, will show that the tendency is to keep the mean effective pressure near to the middle of the stroke, instead of developing the m. e. p. so near to the initial end of the cylinder, and without a doubt the lessened tendency towards cylinder condensation will offset the slight loss in expansion involved. Upon the other hand, after the steam is holding its initial further out in the stroke, and the throttling effect tends to locate the m. e. p. too near the terminal end of the stroke, then the removal of the pressure restrictions will tend to hold back the m. e. p. nearer to the mid-stroke, the range of temperature being kept down by the lower ratio of expansion. This all means a closer approach to uniformity of temperature within the cylinders, and a more constant relative position for the m. e. p. in the stroke. In applying this idea to a triple-expansion with a strictly automatic cut-off in the high-pressure cylinder, with, say, 165 lbs. absolute initial pressure, happening to cut off at a point giving five expansions, there would be an absolute m. e. p. of 86 ℔s. and a terminal of 33 ℔s. But by maintaining the same m. e. p. and by throttling the initial 12 per cent., the cut-off would have to go out to a point giving four expansions and the terminal would rise to 36 lbs.; then the automatic cut-off on the intermediate would provide a balance of power and deliver a constant volume of steam to the low-pressure cylinder at a slightly varying pressure, which, with the practically constant vacuum and fixed cut-off, would go far towards holding the engine under control—like the handling of the team under taut reins. A sudden overload would result in quickly raising the initial and letting out the cut-off on the high-pressure cylinder, and the automatic cut-off on the intermediate would bring the machine under conditions somewhat resembling those of the cross-compound in the moment of need; in other words, the low-grade and the high-grade engines would be combined to meet the extraordinary demands when the need came, and then relapse automatically into a state of high economy when the load permitted.

The general statement of the problem is sufficient to indicate its peculiar difficulties, and the extent to which its solution must be found in wide departure from practice based upon experience gained in other lines of steam-engine design and construction. In the next issue of this Magazine I shall review, concretely, the form which modern practice has assumed in typical large installations—both as to general arrangement of the main and auxiliary machinery and the proportions and constructive features of the engines themselves.

EDITORIAL COMMENT

The immediate result of the conclusion of the war in South Africa will be new stimulus and freer scope to the mining industry—itself a matter of huge magnitude and importance. The further and greater consequence will be a tremendous advancement of the vast schemes for African industrial and commercial development, of which Cecil Rhodes is the genius and of which the Cape to Cairo railway is the central system. It is an imperial project—but the Empire is economic, not merely political.

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One of the objections which has been urged against the automobile is the fact that horses and other animals are apt to be frightened at the mechanically-propelled vehicle. While this objection is more fancied than real, it may well be worth considering whether a source of traction which can be so readily frightened is not the one against which discrimination should be made. If the horse does not like the automobile, so much the worse for the horse.

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In some cases the importance of having a motive power which cannot be frightened must be conceded. In the recent battle near Ladysmith it appears that the reverse to the British arms was due to the stampeding of the mules attached to the ammunition trains, the troops being thus deprived of ammunition at the critical moment. While it is by no means certain that mechanical traction could have been used instead of the nervous mule in this particular case, yet there is every reason to believe that, in very many instances, artillery and supply trains could be hauled by machinery with perfect success, and certainly stampeding would be impossible. It may be that designs suitable even for rough country can be made, which will altogether replace horses and mules in the work of hauling, and the advantages to be gained may be worth considering.

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John Graham Brooks' able review of the Trust craze in America, which we present this month, will be read with interest and profit by thoughtful men throughout all branches of engineering industries. The publication affords us special pleasure because of his strong advocacy of publicity in regard to the affairs of all great corporations. The courts, the banks, the stock exchanges, the newspapers, and students of public policy everywhere have at last been aroused to see that the sovereign remedy for the shameless abuses attending Hooleyism in England and the Trust craze in America is "to turn on the light" and to give every stockholder the right to know all about every company whose shares are offered in the open market.

And what Mr. Brooks says upon the pressing need for better organisation of American railroads, municipal works, and, in fact, public-service corporations of every kind, is absolutely true. These enterprises, now in private hands, must have better organisation and better management, or public demands, led by political demagogues, will land them all in the hands of the State. And when a Republican form of government is confronted by government ownership of railways, and municipal ownership of water works, gas works, electric-lighting stations, and tramways, it is on the highway towards the state socialism which lowers threateningly over so large a part of continental Europe.

But while we agree with him cordially upon the great need for publicity and the necessity for better organisation, we stoutly dissent from the idea that the combination scheme as illustrated in America can have any permanent place in the organisation of manufacturing industries. The great Standard Oil Company has succeeded thus far because nature limits the supply of oil. In like manner the production and price of coal might be controlled, because it is practically a question of acreage. But in manufacturing industry there is no such fixed limit. In the cordage industry, in the production of whiskey, and in rubber manufacture, actual experience has already demonstrated that these combinations cannot permanently control prices, production, or competition. The combinations, in fact, simply stimulate competition, because able men outside the combinations are quick to see that the chances for making money are greatly improved by the mere fact that, in the beginning, combination steadies prices and rids the market of foolish competitors. What we may confidently look for, therefore, is the disintegration, either gradual or sudden, of these stock-gambling ventures, with heavy losses to investors in their shares. Meanwhile, good managers throughout all lines of manufacturing will build surely and strongly while these speculative amalgamations are passing through the rigor of reorganisation.

"The survival of the fittest" is the inexorable law of the industrial world.

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Many apologists for the British manufacturer, in the matter of the contracts recently placed in America, have laid stress upon the part played by overpressure of work in excluding from British works the undertaking of new orders—at least for prompt deliveries. Mr. Slater Lewis, in his excellent contribution to this issue, revives and greatly magnifies this argument. But it is evident that overpressure of work in hand may come from either of two causes—abnormal demand or subnormal ability to meet it.

Whether or not the policy of intensification and specialisation—which is regarded as characteristically American—gives more elasticity to productive capacity is now in a fair way to practical test. The pressure upon the machinery trades of every sort in the States is at present apparently as great as that which has borne upon English manufacturers for several years past. The fact probably is that the needs of the world are so vast as to demand the maximum output of all mechanical appliances and engineering tools. Probably, also, England has long supplied more than her share of such products. The share still seems to be more than she can well supply. There seems small need for her manufacturers to complain, though they are wisely alert for any means of augmenting their capacity.

REVIEW OF THE BRITISH PRESS

Technical Discussions.

EVERY one admits the great value to the engineering profession of the periodical gatherings of the great societies, and realises the importance of the papers which are presented and the discussions which follow, and those who appreciate these features the most will also take much interest in reading a recent editorial in *Engineering* upon the subject of technical discussions, criticising most effectively some of the shortcomings of such meetings.

With the papers which are presented little fault can be found, and often much praise is elicited. and this is only natural when it is realised that contributors to transactions generally treat of subjects concerning which they have had special experience, and give time and care to their presentation. At the same time, however, it is from the discussions that the greatest advantage may be derived, if these are but carried on in a proper manner.

It is practically impossible to predict the kind of a reception which a paper may meet. In some cases an apparently colorless paper, devoted in the main to matter-of-fact description, has set on foot a topic which has led to keen controversy, while, on the contrary, an elaborate paper dealing in great detail with matters on which strong and widely opposed opinions are held, has elicited little or no comment.

"In spite of all the good speeches which are made, it must be confessed that the average of oratory at technical meetings is low. There is, in general, no lack of speakers, and neither is there lack of knowledge; but it often happens that the men who speak do not know, and the men who know do not speak. In addition, we have the man who both knows and speaks, but cannot express himself to any purpose. It is often a wearisome business to sit while one member after another struggles with his ideas, or his want of ideas, and one thinks what an advantage it would have been if the speakers had taken the trouble to commit to paper beforehand what they wanted to utter." This lack of preparation is one of the great evils of discussions at these meetings. Often the discussion is turned toward some side issue, the main question being entirely ignored, and much of the labor of the author of the original paper in gathering facts and preparing to meet possible queries, is wasted.

"If half a dozen men had come with their minds fully made up on that part of the subject with which they were best acquainted, such a thing could not happen, for each would raise a definite issue of importance, and there would be some real and valuable criticism."

This matter of written preparation may, however, be carried too far, and it must not be inferred that immediate and spontaneous discussions may not frequently be of the greatest importance and value. Some of the most important points in a discussion are elicited, not by the original paper, but by the remarks made by a subsequent speaker, and when a real contest of wits backed by real ability and experience is provoked, some of the very best of technical discussions are the result. Unfortunately this does not occur nearly so often as it should. As the writer in *Engineering* truly says:

"The good speeches which are never heard exceed in number those which are heard. How often one feels, in looking around the benches, that there are several silent members who have a knowledge of the subject in hand far beyond that of the speakers! Diffidence holds them back; their very familiarity with the subject leads them to take a depreciatory view of their knowledge, and, besides, they are not prepared. If they had only taken the trouble to put their ideas in order, to search their stores of recorded information, and to crystallise the theories which—perhaps unknown to them—dominate their practice, they might have taken a most useful part in the debate, adding credit to the society, and gaining reputation for themselves. Technical societies would enter on a new career if the members would carefully scan the programmes of forthcoming meetings. and would procure copies in advance of papers dealing with subjects which they understand, with the intention of confirming, or controverting, to the best of their ability, the statements which they contain. It is no slight labour to write a good paper, and such an effort deserves far more recognition than a perfunctory vote of thanks. The writer lays his stores of knowledge before his associates—often before his rivals—and it is a poor spirit which is content to make no return when the opportunity arises.

The Progress of the Steam Turbine.

Ever since the success of the Turbinia there has been much interest evinced in the steam turbine, both in its application to marine propulsion and to the driving of electric generators, and hence the paper of Hon. C. A. Parsons presented at the recent meeting of the British Association demands especial attention.

The paper was intended to be an account of the performance of the torpedo boat destroyer which has recently been fitted with turbine machinery of exceptional power, but unfortunately the completion of these trials was interrupted by damage to the destroyer by collision, and hence only a portion of the preliminary information was available in the preparation of the paper.

So far as the trials have been conducted they show a very satisfactory performance, both as to low steam consumption and freedom from vibration, and when operated under full designed power there is every reason to believe that the guaranteed speed of 35 knots will be attained.

It will be remembered that the Turbinia made a maximum speed of 34½ knots, and did so with the low steam consumption of 14½ pounds of steam per i. h. p., and the measurements so far recorded on the new destroyer seem to justify the expectations of a greater degree of economy in the turbine engines of the destroyers than in the smaller engines of the Turbinia.

The main object of Mr. Parsons' paper, however, was to demonstrate the practicability of constructing larger vessels for turbine propulsion, especially fast steamers for crossing the channel. The advantages of the steam turbine for fast passenger service are obvious. The steam consumption is no greater, indeed is probably less than that of triple expansion engines of equal power, while the total weight of propelling machinery with the turbine system is under one-half that of ordinary screw engines, and under one-third that of paddle engines. Owing to the absence of reciprocating motion there is little or no vibration, and as there is no need of bracing against racking stresses the hull may be made lighter than is now possible. Since no lubricant enters the steam part, the condensed steam is free from oil, and express water-tube boilers of the smaller-tube type may be maintained in satisfactory working conditions for long periods. The smoothness of motion, and the absence of racing, due to the depth of immersion of the propellers, will add greatly to the comfort of passengers, and the increased speed will shorten the voyage materially.

Mr. Parsons has prepared plans for a fast channel-steamer of about 1,000 tons displacement, which, with steam turbines of 18,000 h. p., should make a speed of 30 knots, and if such boats were placed on the Dieppe-Newhaven line it would be the fastest route between London and Paris; while on the Dover-Calais route they would shorten the time by half-an-hour. Two designs have also been prepared for trans-atlantic steamers on the turbine system, one of 18,000 tons displacement, and 38,000 h. p., which should attain a speed of 26 knots, another of the same displacement, but of 40,000 h. p., by which a speed of 40 knots would be made.

The steam turbine has now been in practical service long enough to reveal any radical defects in its design if any such existed, but experience gained in the trying altogether encouraging. In the station at Cambridge it is stated that one steam turbine has run for a year without attention, and that it was in as good condition at the end of the time as when it was first put to work. At that portion of the blades where it was predicted that serious erosion would occur, the file marks were still plainly visible on turbines which had been at work for six years.

There seems to be little doubt that the principle of the turbine is thoroughly established and that, as Mr. Parsons says:

"It is an ideal rotary engine without reciprocating parts, with a uniform turning moment and almost complete absence of vibration, and of extremely small weight." When to this is added a working steam consumption of not more than 15 pounds of steam per h. p., it will be seen how strong are the claims of the motor for marine and electrical service. The completion of the trials of the torpedo-boat destroyers will be awaited with interest, and if the anticipations raised by the preliminary trials are realised there should be no difficulty in procuring the construction of the channel and ocean steamers which have been already designed.

Locomotive Building in England and America.

In a recent isues of *The Engineer* the locomotive trade of Great Britain is discussed at length, and incidentally the methods in vogue in England and the United States are compared.

Until recently, the greater portion of the products of the American locomotive works has been for home use. In England, on the contrary, most of the railway companies build their own engines, and the private locomotive works have been occupied with export trade. Since this trade is of a widely varied nature the builders have been obliged to comply ,to a very great extent with the special requirements of the customers, and the methods of construction have been affected accordingly. A large portion of the foreign trade of the British locomotive works comes through civil engineers. "In other words, Great George Street gives out the orders." In the United States, it is true, the locomotives which are built by private works for railway companies are built under careful inspection, but this is reasonable inspection, while much of the inspection in England is unreasonable.

Then again the greater efficiency of workmen in the United States is an important factor. At the Baldwin Locomotive Works it is said that one engine can be turned out per annum for every five men employed, or with 5,000 men 1,000 engines per annum will be made. In England, on the contrary, the output is about one-half this. A part of this increased efficiency is due to the men, part to special tools, and much to the fact that there is no interference with a man who does more than the rest of his fellows may have elected to consider a day's work.

Much of the cost of English work is due to captious and unnecessary strictness of inspection, requiring alterations and reconstruction where such are altogether unnecessary, merely to satisfy the whims of the engineer who stands between builder and purchaser. This adds not only to the cost, but also to the time required, and this system has had much to do with the length of time required by English builders to fill the orders which they have taken. The American builder, on the contrary, goes directly to the customer, agrees to give him results and takes the responsibility for the means by which he accomplishes them, and, freed from the trammels which hamper his British competitor, he is able to beat him both in cost and time. The English builder may expatiate on the high character of his work, and contend that absolute perfection of workmanship is essential in order that a locomotive may be durable. "The American asks, and asks very wisely, what is the use of building locomotives to last thirty years, which will be wholly superseded and out of date in ten, or perhaps five years."

Great Britain cannot expect to supply the world's demand for locomotives with her present facilities, and if those facilities are not extended other countries will certainly enter the field.

"In this way, and in this way only, is United States competition likely to be dangerous, and its attacks can be parried by adopting American methods. It is beyond question that the older country has much to learn from the newer country. The real danger is that we shall refuse to learn. If Americans can build engines which will do the world's work sufficiently well by the hundred, while Great Britain is turning out only by the dozen, models of mechanical perfection intended to be of use by our grandchildren, we must rest content to stand on one side, and let our rivals go ahead. American engineers do not build for posterity. They think of the present, and leave the future to provide for itself, and the enormous success of their country is largely due to the concentration and grip which is a necessary concomitant of this policy.

Bacterial Treatment of Sewage.

In view of the interest which has been taken of late in the bacterial method of purifying sewage, the second report of Drs. Clowes and Houston to the London County Council upon the work of the purification beds at Crossness is important.

The principal information given by this report is the action of coke beds upon sewage, especially in the case in which the fragments of coke are as large as walnut size. Three beds, of 4, 6, and 13 feet in depth, have been subjected to careful working tests, the results on the first two extending over a period of about 10 months and on the third, for about 9 weeks. Through these beds the crude sewage as delivered at Barking and Crossness is passed, and the results of careful chemical and bacteriological examinations before and after the operation are collected and exhibited in the form of diagrams.

The general process is to allow the raw sewage to flow on to the surface of the bed and to remain upon it for about three hours, after which it is slowly drawn off and the bed allowed to stand empty for eight hours in order to permit the coke to become aerated. Twice a week the surface of the coke is raked over, to keep it open, otherwise no manipulation appears to be necessary. The coke does not appear to become foul or display a tendency to break up, and the principal changes which take place are the partial covering of the pieces with a soft matter consisting of particles of woody and vegetable tissue with some fine sand, while the ash is reduced by about 25 per cent.

A single treatment of this sort removes 51.3 per cent. of the dissolved oxidisable and putrescent matters, and all of the suspended matter, and the effluent remains free from objectionable odours when kept in open or closed vessels, and is not injurious to fish.

The treatment does not appear to remove the bacteria from the crude sewage, and while the presence of many bacteria is doubtless unobjectionable and probably necessary for the completion of the purification of the effluent after it has passed into the stream, doubtless some pass through which would be objectionable in drinking water. This shows, in the words of the report: "that the coke beds were highly efficient from the point of view of solution of suspended organic matter and a partial destruction of dissolved and offensive substances, and as a preliminary measure tending in the direction of complete disintegration and ultimate purification of the crude sewage, but that they were unable to bring about the complete resolution of the organic matter."

This brief abstract shows that the use of the simple coke bed will at least enable sewage, originally foul, to be delivered into a stream without rendering it in any way objectionable, and streams which must receive sewage-discharge may at least thus be prevented from becoming open sewers. It is more than probable, also that a further purification takes place after the discharge of the effluent, and water from such streams would need only slow sand filtration in order to be rendered fit for drinking.

As the report is not offered as a final one, and as the tests are to be continued, we may look for more information from this important installation hereafter.

American Competition.

Although much has been said and written about the competition of American manufacturers with Englishmen in fields where until recently the latter have had supreme control, there has nowhere appeared such an exhaustive discussion of the matter as that which has recently been published in the columns of *Engineering*.

This series of papers, written by a number of prominent English and American engineers, may be considered as a symposium upon this important subject, entirely free from prejudice or animosity, covering the field from the view-point of the engineer and manufacturer in a manner which cannot fail to interest and instruct the parties most directly interested on both sides of the Atlantic.

In the first place all the writers assume without question that the competition of Americans with British industries exists, that it is increasing, and that if something is not done to meet it that many English markets will either be lost entirely or divided with the successful competitor. The reasons for this recent invasion into British commercial preserves are variously attributed to causes more or less apparent, as the following quotations will indicate.

So far as the influence of the British workman as such, is concerned, Col. Stevens says: "The English workman is the equal of any, but not if he is in England." His principal reason for this statement is, that in America the workman's ambition is absolutely uncurbed, and that therefore he is willing to co-operate in methods for increasing output and reducing piece-cost if he can thereby improve his own position. Says Mr. William Kent: "What of the English workman? He has a fundamental fallacy implanted in his brain to the effect that the total amount of work done is a limited quantity, and if he does too much in a day, or obtains the help of a machine to do more than he has done, there will be less work for him to do to-morrow or else he will be reducing the amount to be done by his fellow workman." Again, Mr. John Thomson quotes: "The chief trouble with foreign mechanics is that they know only one branch of the business, which is due to the laws of their trade unions, which in many cases prohibit the working or running of more than one machine; hence they learn only one branch of the business. This is especially the case with the English trade union mechanic."

Turning now to the British employer, his conservatism is held to be largely responsible. "It must be admitted that we Britishers have our prejudices, and so strong are they very often, that we stubbornly stick to old methods when newer and better ones have been discovered." This from Mr. George Howell. In like manner Mr. William Kent says: "England's trouble with American competition to-day is not due to any fault of geographical location, nor to any failure of natural resources. It seems rather to be due to the natural peculiarities, or to the prejudices of her people." An anonymous English contributor to the symposium says: "The Englishman is too conservative to willingly try foreign methods. Until recently the average Englishman was profoundly ignorant of what was being done abroad, and was unwilling to believe any statement which he had not verified with his own eyes." Mr. John Thomson shows that the characteristics which have made England a leader in the world's industries have also acted to retard her progress. "The condition indicated (*i. e.*, her present high position) has been largely produced or made possible, from those splendid British characteristics, tenacity of purpose, perseverance, stubbornness, patience, loyalty, respect for usage, and maintained performance of duty according to conscience or under orders. These attributes, when applied to new fields of progress, mean slowness of change from existing methods; more or less of defiant, crusty opposition to modification; satisfaction with that which has been accomplished in the past, and stolid confidence, or indifference, as to the results of the future."

Thus much from the side of causes acting in England. Turning now to America, we find that practically the opposite conditions have existed. Speaking of the American workman, Col. Stevens says: "He recognises that he can aspire to almost any position; that ability is quickly recognised, and that, a journeyman to-day, he may to-morrow become a foreman, and a proprietor the next." Mr. Kent remarks: "There is no tendency to reduce the daily wages of labour in American machine works, but on the contrary, the tendency is to advance them. The piecework system is used to a great extent, and the workman does not object to tending two or four or six machines, if he is able thereby to increase his daily wages." Again, the same anonymous contributor before quoted, says: "In America the harder a man works the better he is paid, and there is little time or inclination for loafing." Everything has thus acted to limit the productiveness of the workman in England and to increase it in America.

The progressiveness of the American proprietor is well-known, and so far from pointing with pride to a machine which has been in use for more than 90 years and tended by three generations of the same family, he endeavours to drive his machines to death, in order that he may get the full value out of them before they become obsolete.

Nearly all large English works are managed by elderly men, whose great capacity is admitted, but whose opposition to change is also well-known; while in America managers are usually much younger, and are constantly on the lookout for improved machinery and methods.

Taking these general abstracts as typical of the whole discussion, we have the summing up of Mr. Thomson:

American industries are able to compete successfully with those of Great Britain: "because of better organisation; more complete adaptability of system; greater incentive; a higher, or broader, development of engineering as a profession; ready flexibility to meet new conditions, and because low-priced craftsmen in Great Britain may, and do, more quickly become high-priced master workmen, or foremen, or superintendents and proprietors, when transferred to America."

Tramways in the United Kingdom.

In view of the rapid progress which has been made in electric tramway construction and operation in other countries, and the backwardness which until very recently has been the condition in Great Britain, an article in the *Tramway and Railway World* upon the early future of electric tramways in the United Kingdom is of much interest.

There are two lines along which development may be expected. The first of these naturally is the conversion of existing roads. About one-fourth of the 1,200 existing miles of tramway in the United Kingdom are at present operated by electricity, and, so far as the populous centres are concerned, from five to ten years' time will probably see at least three-fourths so equipped, and probably most of this will be on the overhead trolley system. Where the existing owners are unable or unwilling to make the change, others stand willing to do so when allowed, so that there seems every prospect of a speedy end to the horse as a motive power for tram-cars, a consummation devoutly to be wished on the score of humanity, cleanliness, and economy.

The re-equipment of existing lines, however, forms only a portion of the construction which may be expected, and there ought to be, and in all probability will be, almost as much progress in the direction of new lines and the extension of old ones as in the change of power for the present tramways. The amount of work involved in this transformation is very large, and an estimate of its value will be of interest. Taking the present mileage already equipped with electricity, or very shortly to be so operated, and assuming the low cost of £8,000 per mile, we have a total of £2,800,000, or in round numbers £3,000,000, and this will doubtless be doubled in the next five years.

"By 1910 we shall probably see 900 or 1,000 miles of these old lines operated electrically, and as great a length in addition of new lines—tramways and light railways—built, perhaps at a slightly less cost than the old ones, but still averaging at least £6,000 per mile of route length. Very many of such new lines would consist of single track with passing places; a low average, at about the above rate, may therefore be taken. A thousand miles of double track at £10,000, and another thousand at £6,000, bring the total up to £16,000,000, which may be looked upon as the minimum amount of capital to be invested in electric tramway lines in Great Britain before 1910."

The exact conditions under which this work will be done cannot yet be altogether foreseen, but that it will be done by some one, and done under satisfactory conditions may be distinctly understood. It represents just that much new work developed where it did not before exist, and it will be done either by home labour, home engineers, and home capital, or it will go to the foreign competitors who have already gotten their foothold in this very line of construction.

A very important question in this connection is that of deciding what interests shall best carry on the work. Shall it be done by the municipality or by private management? If the municipality so chooses the public body can always have the preference, but those who have had much experience in this particular direction feel that the municipalizing tendency in regard to tramways may be carried too far. Indeed it is frequently stated that the retarding influence of municipal control is the immediate cause of the backwardness of Great Britain in electric traction. Apart from this much-discussed question there is no doubt that experience has shown that the most successful development of electric tramways lies in the construction of connecting lines, and indeed in the United States, the communicating lines often run through and within several adjacent towns, a most valuable plan, easily carried out under private ownership, but difficult indeed under mixed municipal control.

There are doubtless two sides to this question, and while private enterprise has been most successful in other countries, a number of corporations have also done well, and with capable and independent men at the head of tramway committees there is no reason why good work should not be done by municipalities.

Be this as it may, there is no question that the work is coming and must be done by somebody, and whatever view may be taken in regard to the proper method of extending tramway facilities, there is not the least doubt that there will soon be remarkable developments in which both private and municipal enterprise will both play important parts.

Photographic Surveying.

VARIOUS papers upon the possibility of applying photography to surveying have appeared from time to time, the most practical being the work of Mr. Deville for instruction in actual work on the Canadian survey. We now have a general résumé of the whole subject in the form of a paper before the Society of Engineers by Mr. J. Bridges Lee, including an account of some improvements which he himself has made in the instruments, and a description of the method employed in the Canadian survey for plotting the maps from the photographs.

In producing a perspective drawing from plane projections the object is to produce from what may be termed maps, a picture of the subject as it appears to the eye. Photogrammetry, as it has been called, is the reverse operation, the production of the map from the perspective, and, as the paper shows, there is no difficulty in producing excellent work very rapidly by use of the camera, if proper precautions are taken in making the views from which the subsequent work is done.

After referring to the original objections to the use of the camera as a surveying instrument Mr. Lee shows how the introduction of gelatino-bromide dry plates and modern photographic lenses have enabled the real difficulties to be overcome, and the only remaining objections to the method for general work arise from the conservatism and inertia of professional workers, and an unwillingness to take up with the new method so long as the old ones will be accepted.

Apart from the rapidity of the method, the great advantage lies in the fact that when the photographs have been taken they contain all the data, so that omissions or the discovery of errors of measurement cannot occur to require revisiting the field. This is of especial importance in connection with the work of explorers and military engineers, who by the use of the surveyor's camera may secure photographs to be subsequently worked up by others.

The principal improvements which Mr. Lee has made in the instrument are: the introduction of horizontal and vertical hairs in contact with the plate, giving bases for measurement, and positive indication of the presence of distortion; the placing of a compass with transparent scale inside the camera in such a manner that the vertical hair serves as an index for reading the compass bearing; and the introduction of a scale, photographed by contact on every plate, enabling the exact focal length of the lens to be determined. He has also arranged hinged carriers so that data relating to any exposure may be written on transparent pieces of celluloid and inserted so that they will be printed directly upon the negative, thus avoiding any uncertainty as to the identity of a negative, or doubt as to the data which belong to it.

In connection with the field work, the same general rules apply in the selection of stations as obtain in plane-table work. The important thing is to remember that the topographer in the office cannot obtain good intersections from cross views which would not have yielded good intersections in the field. A moderate degree of experience in both photographing and plotting will soon teach the operator how to select his views, and the work will be found far more rapid than that with the plane table.

As already indicated, the plotting work is the exact reverse of the making of a perspective drawing. The points are identified in each photograph, transferred by strips of paper to the trace of the picture-plane, and to the distance line, and threads stretched from the station points to corresponding points on these lines give by intersection the positions of the points on the plane.

Judging from the success of the method on the Canadian survey the method will probably come into extensive use elsewhere.

The Crystalline Structure of Metals.

THE study of the physical constitution of metals and metallic alloys by the employment of the microscope in connection with etching processes continues to add much to the engineer's stock of information concerning the reasons for the behaviour of such material under various conditions, and one of the latest contributions to this branch of science is the Bakerian lecture of Professor J. A. Ewing before the Royal Society.

Most of the researches in metallography which have thus far been made relate to the physical constitution of the metal after it has been cast, wrought, or otherwise prepared for use, but this paper discusses the effect produced upon the structure by the application of stresses, and consequently undertakes to reveal the nature of what is called strain.

The result of the study of metallography has established the fact that a metal is a structure composed of irregularly-shaped grains, with clearly defined boundaries, and these grains have been shown to be crystals formed upon solidification. The nature and dimensions of these crystals depend upon the composition of the metal, upon the rapidity of solidification, and upon the subsequent treatment, but it is now believed that under no circumstances does any metal cease to be crystalline.

When, by polishing and etching, the crystalline character of any metal has been determined under the microscope, it is practicable to determine the extent to which this structure is modified by subsequent stresses. If the stress does not exceed the elastic limit, the structure does not appear to be materially affected, but if a greater stress is applied the effect becomes distinctly apparent. When in any way the stress exceeds the elastic limit, lines appear upon the surfaces of the crystalline grains, these lines generally being straight and parallel for each grain, but changing in direction from grain to grain. It is possible, by examining these lines, to determine the boundaries of the crystals even though the surface has not been previously etched, and as the stress continues to be applied the lines increase in number and distinctness, several systems appearing on each grain.

These lines indicate slips along the cleavage planes of the crystals, their appearance varying according to the character of the illumination, and, since observations indicate that they appear in all metals, they may be taken as evidence of the general crystalline nature of metallic substances. The fact that these slips occur along cleavage planes permits the metal to retain its crystalline structure during so-called "flow," the gliding taking place over the cleavage planes and the elementary pieces retaining their crystalline character. Sometimes the yielding is by simple slippage, the orientation being preserved unchanged, at other times it produces twinning, rotation occurring through an angle which is the same for each molecule of the twinned group, and both modes may be found occurring together.

A knowledge of the manner in which the crystalline particles of metals yield should go far to assist in the study of test specimens taken in actual practice, and, there is every probability that this branch of metallography will find useful practical application.

REVIEW OF THE CONTINENTAL PRESS

The Driving of Electric Generators.

EVER since the introduction of the dynamo-electric generator into commercial service the question of the best method of driving it has been a subject of discussion, and at the present time the subject of the power portion of an electric plant really constitutes the most important section of the work.

The question of the choice of motive power and the best methods of application form the subject of a paper by Herr Robert Friese, published in the *Zeitschrift des Vereines deutscher Ingenieure,* and presented before the recent convention of that society at Nürnberg.

After referring briefly to the electrical magnitudes of voltage and amperage as related to the mechanical elements of force and distance and showing how the equations giving the relations of electricity generated to power required may be derived, Herr Friese proceeds to consider the various methods of connecting the generator to the source of motive power by which it is driven. The development of the direct-connected generating set is discussed and the important influence which this development has exerted upon steam-engine design is shown to have been for the improvement of both generator and engine. With the earlier dynamos the high rotative speed required demanded quick-running engines, and although some very excellent machines of this type have been made, such as the Westinghouse engine in America and the Willans in England, yet it is generally conceded that the best economy is attained by larger engines operating at moderate rotative speeds. The improvements made in large alternating and polyphase generators render it possible to use such engines in direct connection with the generators, and this type, with vertical engines and large armatures built directly upon the engine shafts, is the prevailing form now used in large electrical stations where steam is the motive power.

The question of speed regulation has naturally been given much consideration in connection with the subject of driving electric generators, and Herr Friese has some interesting remarks to offer in that connection. While the centrifugal governor maintains its supremacy, in spite of its inherent defects, the demands of electric service have resulted in various improvements in the matter of speed regulation. The natural auxiliary of a governor is a fly wheel, and in one form or another the inertia of a revolving mass is generally relied on to assist in the maintenance of uniform speed. The usual method of expressing irregularity in speed is that of a percentage variation from the normal, it being stated that the speed shall not vary, for example, more than 2 per cent. above or below the standard, but this method does not give a clear idea of the conditions because it fails to take into account either the duration of the regulating operation or the number of variations from the normal which may occur during that time. The fluctuations of electric lamps, however, make both the extent and duration of speed variations visible. Herr Friese calls attention to the difference in sensitiveness of people in different walks of life to variations in brilliancy of electric lamps, and shows that fluctuations almost unbearable to persons of culture were hardly perceptible to the peasant laborer, so that the personal equation must be considered in this connection, as well as the service to which the light is to be put. As a matter of fact, the degree of variation in speed is not a constant factor, as some treatments consider it, but is a resultant of varying influences in every portion of the combined machines. All that can be expected is the restriction of the variations within certain predetermined limits, and this should be effected not only by regulating the impelling power after the variations have occurred, but by so combining the parts that the variations may neutralize each other as nearly as possible, and at as early a point as possible after their inception.

As an example of what can be done in this direction, the subject of the connection of electric generators in parallel is discussed, and the equalizing effect of two generators is illustrated by comparison with that of two engines geared in parallel with a certain degree of elasticity in the connections. The use of accumulator batteries for the purpose of equalizing variations in the load is also considered, and the analogy of such batteries to fly-wheels is clearly shown.

The probable use of gas engines for the driving of electric generators is considered, and although the single cylinder four-cycle engine is considered unfit for this service, Herr Friese maintains that with two or more cylinders, and with proper arrangements for the equalization of the load, there is no reason why the internal combustion motor, with its superior economy, may not come into general use as a motor for dynamo-electric machines.

Modern Sewer Construction in Paris.

THE extensive works which have been constructed near Paris for the purpose of conveying the sewage to the farms and disposal grounds below the city have been the cause of the development of some novel and valuable methods of construction, and from a paper by M. E. Fourrey in a recent issue of *La Revue Technique* some account of the methods of the various constructors may be taken.

The general character of the great undertaking by which the whole of the sewage of Paris has been diverted from the Seine and delivered over farm land to be utilised and purified before it gets into the river, was described in these columns more than a year ago, and it was then shown how the location of bends in the river rendered the construction of inverted siphons necessary. The siphons under the Seine have been constructed of riveted steel, but apart from these there are in the system a number of siphons traversing low lying ground and much large closed sewer work of importance. The construction of the great Clichy sewer, of which much has already been written, forms only a part of the system, and the portion of the work which is now of especial interest is that of the reinforced concrete conduits, of which a number of illustrations are given in M. Fourrey's paper. As a matter of fact, the extensive use which has been made of reinforced concrete in various parts of the extension of the Paris sewers has done much to attract attention to the general advantages of this mode of construction. A great part of the main aqueduct, together with the conduits for the distribution of the sewage over the irrigated area, has been made of reinforced concrete, with most satisfactory results as regards strength, tightness, and economy, the only objection to this work being that in case of change the old conduits cannot be taken up and relaid elsewhere as can be done with metal pipes.

The most interesting example of construction is that of the Chennevières siphon, which consists of a conduit 6.28 feet in diameter and 1¼ miles long. Since the maximum head is about 42 feet the pressure is about 18 to 20 pounds per square inch, which is readily sustained by the cement and imbedded metal. This conduit is formed in sections consisting of cylindrical metal cages, the circular members composed of T iron with longitudinal connections of channel bars, the whole being interlaced with an intermediate trellis of round rods. These sections were placed in position in the trench and a concrete of Portland cement filled in in such a manner as to enclose the metallic skeleton entirely, thus forming a smooth continuous tube having the tightness and durability of cement pipe together with the strength of the metal reinforcement, and the added advantage of the absence of joints.

Another example of the successful use of reinforced concrete is found in the large tunnel for the Argenteuil siphon. In this case the conduits themselves are of steel pipe, two such pipes being carried across the Seine on the handsome steel arch bridge recently constructed for the purpose, these pipes then passing through the tunnel. This latter is of elliptical section, 17 feet wide and 11 feet high, and is built of concrete applied to a skeleton of steel rods, erected in place and connected together so as to form a continuous reinforcement of the whole structure. The circumferential members of the skeleton are of round rods

⅝ inch in diameter, bent to the form of the elliptical vault and secured at the ends to channel bars imbedded in the concrete at the springing. These arch rods are interlaced with longitudinal rods 5-16 inch in diameter, forming a trellis with spaces about 4 inches square, and as the metal work was erected it was filled in with cement to a thickness of about 3 inches, the whole hardening into a solid mass of great strength and tightness.

The successful use of reinforced concrete in such important structures should be followed by similar applications in other parts of the world, especially where cheapness, strength, and rapidity of erection are to be considered.

It is interesting to note that the works were completed in July of the present year, so that now all Paris wastes go into the sewer and none into the Seine.

The Strength of Rubber Hose.

THE introduction of steam heating in railway carriages has made it necessary to provide rubber hose connections which shall stand the rather severe duty of this peculiar service. In the case of air-brake hose the problem is confined to securing tightness against leakage of air under pressure, and endurance of the wear and tear of operation and handling. For steam heating connections, however, there are effects of steam and the action of hot water to be considered, and experience has shown the necessity of providing strict specifications and exhaustive tests, in order to insure satisfactory results.

A series of tests has recently been made at the Government Testing Laboratory at Charlottenburg, and the results are now made public in a paper in the *Mittheilungen* by Professor Rudeloff, and as the subject is one of international interest an abstract of his paper is here given.

The requirements of the German government for steam hose are very strict, and are in substance as follows:

The hose is to be made with five layers of pure linen with sheet rubber between, and is to be covered without with linen. It must stand an internal pressure of 150 pounds per square inch, either hot or cold, without injury, and when subjected to internal pressure of 60 pounds for four hours should not twist. The rubber must be free from foreign substances. A temperature of 350° F. sustained for four hours should not affect the strength nor injure the hose in any way. The presence of hot water under pressure should not cause the linen to be easily separated from the rubber nor the layers of rubber from each other.

Holding these requirements in mind, the tests made by Professor Rudeloff may be considered in brief.

After a careful measurement and inspection of the samples they were subjected to an internal pressure of 150 pounds with water at the temperature of the air, with water at 170° F., and with steam pressure. A pressure of 60 pounds was then maintained for three hours, and an inspection for defects then made, after which the sample was subjected to a heat of 350° F., both with steam and with dry heat, and the strength of the material then examined. The adhesion of the linen to the rubber was also determined, both for the original condition and after exposure to the action of boiling water.

The specimens tested were about 22 inches in length, 1⅜ inch internal diameter with walls ⅜ inch thick, and examination showed that the rubber penetrated the fibres of the linen so that it appeared to be of one entire mass. A number of samples were tested, and the results are tabulated fully in the original paper, together with a description of the apparatus used. The circumference of each piece was carefully measured near each end and in the middle, both before testing and afterwards, as well as during the application of the pressure, and similar measurements were made of the length.

So far as resistance to cold water pressure is concerned, the specimens tested gave excellent results, the slight increase in diameter under 150 pounds pressure disappearing entirely when the pressure was relieved. The corresponding tests with water at 170° F., resulted in a permanent increase in circumference of about ¼ inch, but the hose appeared otherwise unaffected. The specimens, however, failed to resist satisfactorily the test of 150 pounds steam pressure, as the circumference was enlarged nearly an inch and the length diminished 0.6 inch, while the outer covering was loosened and partly destroyed. The twisting action which takes place consequent upon prolonged internal steam pressure was shown by the fact that one specimen twisted 15 degrees when under steam pressure of 60 pounds for three hours, with a permanent twist of 8 degrees, and another specimen showed 9 degrees twist and a permanent set of 2 degrees.

The action of prolonged heat varied according to the manner of application. Rings cut from various portions and opened out, were pulled in the Rudeloff testing machine, both in the original condition and after heating. Exposure to steam heat at 350° F. for four hours made the rubber much softer, the extensibility under given load being increased fully three times and the ultimate strength diminished to less than one-fifth its original amount. Exposure to dry air at 350° F. for four hours, on the contrary, made the rubber harder and diminished the extensibility very greatly, although the ultimate strength was reduced nearly as much as with the steam.

When the material was exposed to the action of boiling water for half an hour the adhesion of the linen layers to the rubber was not appreciably reduced.

In view of the importance of producing hose which shall satisfactorily meet the requirements of the German railways these tests should prove of especial value not only to manufacturers of rubber goods, but also to the engineering profession generally.

Electric Driving in Rolling Mills.

In applying electric power to the driving of machine tools it was at first assumed that such motors could only be advantageously used for moderate powers and where the load was comparatively uniform. With increased experience, however, the adaptability of electric driving has been extended to larger capacities and to a great variety of work, and in a paper by Herr O. Lasche, in a recent issue of *Stahl und Eisen* an interesting account is given of the successful installation of electric motors for the driving of the rolls for copper wire and rod in the establishment of the Allgemeine Elektricitäts-Gesellschaft at Berlin.

The driving of rolling mill machinery has always rightly been considered a severe test of the regulation of any motor, and builders of steam engines have made especial efforts to improve the governors of direct-connected engines for this work in order to control the speed successfully under the sudden changes from full to no load, as the rolls must be operated. The experience of the above company, however, shows that the difficulties have been successfully overcome in this case, and doubtless this experience will lead to a wider extension of the use of the electric motor for this line of work.

The machinery of this plant consists of four sets of heavy rolls and seven of fine rolls, these being used to reduce copper bars of 60 kilogrammes weight and 0.8 square decimetres section to wire of 7 millimetres diameter, the output per day of 11 hours being about 200 kilometres of wire, the day's work requiring about 27,000 kilogrammes of copper. The heavy rolls are driven by a polyphase motor of 200 h. p. making 380 revolutions per minute, connected by rope gearing through sheaves of 1.4 metres and 5 metres respectively with the main roll shaft. The fine rolls are driven directly by a polyphase motor of 400 h. p. making 420 revolutions and directly connected, a fly-wheel being attached to the motor.

Without going into details of the work performed by this machinery in this particular installation it may be of interest to examine the investigation which Herr Lasche gives of the behaviour of the polyphase motor under sudden fluctuations of load, together with the influence of the fly wheel as an equalizer.

The action of the armature of the motor may be compared to that of a pulley driven by a belt. When there is little or no load the perimeter of the pulley travels at practically the same lineal speed as does the belt by which it is driven. When, however, the load is thrown on there is more or less slip. In the case of the electric motor the rotary field corresponds to the belt, and the loss in speed of the armature when the load is thrown on resembles the slipping which takes place in the case of the pulley.

When a motor is used under sudden fluctuations of load, as is the case in driving rolls, the action, in connection with that of a fly wheel, may be divided into two phases, the period of work and the period of recovery. As in the case of a steam engine or other motor the fly wheel, by its inertia, acts as a reservoir of energy, at first assisting the motor to tide over the sudden demand, and then in turn preventing the sudden release of load by demanding a return from the motor of the energy which it advanced a moment before. By plotting these relative actions in the form of curves, the fluctuating load of the rolling mill may be combined with the absorbing and recovering action of the fly wheel, and the equalizing effect upon the load which reaches the armature of the motor is well seen. Several such diagrams are given by Herr Lasche for fly wheels of different masses, and the influence of a change in the weight of the wheel is thus seen.

In the case of the heavy rolls in the mills above described, the diagrams show that the speed of the main roll-shaft falls only from 105 to 103 revolutions when the load increases from 80 to 220 h. p. in the short space of 20 seconds. Similar good regulation appears in the case of the fine rolls, the speed of the motor falling from 420 revolutions to 410 in the 12 seconds in which the load jumped from 80 to 360 h. p.

The entrance of the electric motor into this difficult field of service is one more demonstration of the applicability of this form of driving not only to heavy machinery, but also to machines operating under the most trying of work-shop conditions.

The Turbines at Rheinfelden.

The great hydraulic power plant at Rheinfelden has been described in various publications, as its importance demands, and these accounts were naturally of the general character which the broad interest in the work has awakened. We now have a special description of the turbine wheels themselves in an interesting paper by Professor Franz Prásil, in the *Schweizerische Bauzeitung*, and in view of the special problems of the case the paper demands notice.

The difficulties encountered at Niagara were mainly those due to the great head of water and the transmission of large units of power from the depths of the wheel pit, the head of water being practically invariable. At Rheinfelden, on the contrary the mean head of water is only about 12 feet, with a variation of more than 3½ feet between high and low water, so that turbines of large diameter were required, and the question of close regulation demanded especial attention.

The requirements of the engineers were that each unit should have a minimum power of 840 h. p. at 55 revolutions per minute with the lowest head of 10½ feet, and that there should not be an appreciable difference in efficiency between the performance at this head and at a head of 13 feet. To meet these conditions it was decided that each unit should consist of two wheels upon a single shaft, each wheel being made in four sections, of 7.6 feet in diameter, the sections being made of such depths as to permit the development of 840 h. p. for the various changes of head under which they might work. By the use of annular sleeves, controlled by the governing mechanism, the flow of water can be cut off from the several sections successively and thus the power regulated without the loss of efficiency consequent upon the operation of a large single turbine at part gate.

In general design the turbines are upon the Francis inward-flow principle, and as it was very necessary to avoid disturbing interference of currents in the discharge water there were three outlets provided for each unit. The water enters through the guide vanes and, passing through the buckets of the revolving wheels is delivered, half upward and half downward from each wheel, so that there is required one discharge channel between the two wheels, one above the upper wheel, and one below the lower wheel, these three uniting into a single large delivery passage or tail-race. The middle and lower passages are formed in concrete, reinforced with imbedded steel beams, while that from the upper sections of the upper wheel is of sheet-iron. Both wheels are mounted on a vertical shaft 11.8 inches in diameter and about 50 feet long, this shaft carrying on its upper part the rotating portion of the electric generator.

The regulation is effected by means of a centrifugal governor which controls the movement of the annular gates encircling the guide vanes of each ring, or section, of the wheels. These sleeves are connected by rods to the pistons of differential motors, the valves of which are controlled by the governor. With this apparatus the speed regulation is effected within a variation of about 6 per cent., notwithstanding the fact that the head of water varies nearly 30 per cent. from the mean, in addition to the varying demands for current upon the electric generators.

It was originally intended to install 20 of the units, each of 840 h. p., operating at 55 revolutions per minute, but after a portion of these had been erected it was decided to increase the speed to 68 revolutions, this being found more suitable for the electric generators. This change was accomplished by a change in the proportions of the remaining wheels, and in Professor Prásil's paper the dimensions of both types are given for comparison. There are now in use 9 turbines running at 55 revolutions, and 11 at 68 revolutions, and the whole set, constructed by Messrs. Escher, Wyss & Co., of Zurich, is operating in a very satisfactory manner.

Seasoning Wood by Electricity.

The importance of thoroughly seasoning timber before it can be satisfactorily used in the arts is well known, and many varieties of kilns and drying devices have been constructed to facilitate the operation of preparing the green wood for conversion. The principal difficulty about existing processes is the length of time required for even a superficial seasoning, and even with great care it is difficult to ensure the thorough drying of the inner portion of heavy timbers.

A new process has recently been devised in France by MM. Nodon and Bretonneau, in which the action of an electrical current to produce osmose is utilised, and from an account in *L'Electricien* the following account is abstracted.

The material which we call wood consists essentially of two portions, one consisting of the cellulose or fibre together with the lignose, or binding material, while the other portion is the sap, or liquid. The sap is composed of water containing albuminoids and nitrogenous matter, and while in the living tree its presence is as essential as is the blood to a mammal, yet it contains the elements which produce rapid decay in the felled timber. The process of seasoning, therefore, is really nothing more than the removal of sap, and upon the completeness with which this removal is effected depends the durability of the resulting timber.

Ordinary drying, even if completely effected, only partially accomplishes the desired object, since much of the putrescible matter is only held in suspension in the water of the sap and remains in the pores of the wood ready to start and propagate decay. Even this incomplete seasoning, however, is most difficult to accomplish entirely, and it is well-known that long periods of time are required to produce a satisfactory result. The pine which is used for the sounding boards of pianos, for instance, is sometimes kept for many years before it is found suitable for use, and it is difficult to insure complete drying under any circumstances.

It is well known that an electric current in traversing a porous substance will carry with it the particles of a liquid in which the porous body is immersed, and it is this property which has been utilised in the new process. After making many attempts to drive out the sap by pressure, suction, soaking, etc., MM. Nodon and Bretonneau tried the effect of an electric current. The experimental process was as follows:

A stick of green wood was placed in a vat, a piece of sheet lead beneath the wood forming an electrode, and the vat being filled with water, leaving the upper part of the wood above the surface. Upon the upper surface of the wood was then placed a vessel having a porous bottom and filled with water, into which was plunged the other electrode. After the passage of the current for several hours it was found that the pores of the wood were entirely filled with water, while the sap was transferred to the body of water in the vat. The wood then being removed and exposed to the air, rapidly became thoroughly dry, the water evaporating much more freely from the pores than could the gummy sap, and when dry the wood was found entirely free from any matter liable to promote decay.

It is evident that some liquid other than water might be used in the porous vessel placed above the timber, and the whole mass of the wood might thus be fully charged with an antiseptic preservative if so desired.

The electrical resistance naturally varies according to the nature of the wood, as well as to the thickness and humidity of the specimen; on an average the passage of a current corresponding to 6 electric h. p. is sufficient for a cubic metre of wood. The usual time required for treatment is 3 to 4 hours, with a current of 10 to 15 amperes.

A careful examination of the effects of the passage of an electric current through a timber in the above manner reveals the following results:

A portion of the salts which may be contained in the solution penetrate by electro-capillarity into the pores of the wood.

An osmotic exchange occurs between the constituents of the sap and the solution employed, this exchange being effected throughout the entire mass of wood traversed by the current. At the same time an electrolytic action occurs which converts a portion of the salts contained in the sap into inorganic compounds, not liable to decomposition. This electrolytic action appears to destroy the living character of the sap without requiring it to pass through the intermediate decomposing stages. It is also maintained that the action of the current tends rather to toughen the fibre of the wood itself and improve it rather than act injuriously.

The extent to which these claims will be confirmed by actual experience can only be determined after the lapse of time, but the principle appears to be sound and the method is so fully described as to enable experiments readily to be made.

Automobiles in France.

The early development of the modern automobile vehicle in France has naturally led other countries to look thither for the results of experience. This is the more natural because there has been much competition, besides various trials, exhibitions, and reports, while the freedom which has been permitted in the use of all kinds of motor vehicles renders the information thus obtained of a most practical nature.

The general reports of the competitions of 1898 and 1899 have appeared in various publications, and have been reviewed from time to time in these columns, but now we have a critical discussion of the engineering side of the information obtained from these trials in the form of a paper presented before the *Société des Ingénieurs Civils de France* by M. G. Forestier, the well-known inspector general of the *Ponts et Chaussées.*

So far as automobilism as a sport or recreation is concerned, M. Forestier regards the question as entirely settled, and hence devotes himself entirely to the practical side of the problem of commercial mechanical traction on public highways.

The trials of 1898 were of heavy road vehicles, and for this service the only motive power attempted was either steam or gasoline.

The steam vehicles were fired with coke, with heavy oil, and with gasoline, while in a number of instances internal combustion motors were used, the gasoline acting directly in the cylinders.

For tabulated details of the tests reference must be made to the paper of M. Forestier, but the general conclusions are that steam power is the best where sudden demands for power are made such as steep grades or starts on ascending inclines, while an internal combustion motor is satisfactory for fairly level roads and is much lighter in weight. Both classes of motors showed a notable advance in economy over similar vehicles tested in 1897, and there is prospect of further improvement in this respect.

Deducting the weight of the vehicles, the cost of hauling merchandise on common roads by steam motor vehicles is given as 0.373 franc, 0.200 franc, and 0.140 franc, per ton-kilometre, according as they are operated with 1-3, 2-3, or full load, while for the internal combustion motor the corresponding costs per ton-kilometre are 0.673 franc, 0.369 franc, and 0.268 franc.

Since the average cost of animal traction under similar conditions is about 0.25 to 0.30 franc, it is evident that mechanical hauling of merchandise can only compete successfully with horses when full loads are carried. When unbroken loads of 9 to 10 tons are to be transported at speeds above 4 kilometres per hour the motor vehicle is the only one which can be used, and it is believed that the improved merchandise trucks will prove capable of speeds up to 6 kilometres with heavy loads as a consequence of the experience gained from these trials.

The details of the trials of the light vehicles are too voluminous to be discussed at the present time, but the following tabulation of costs per day for the operation of cabs and delivery wagons will be of interest.

	Cost per Day.		
	Horse.	Gasoline.	Electricity.
Cab	19.26f.	16.27f.	18.48f.
Delivery Wagon .	16.72f.	12.80f.	14.80f.

The figures include interest, depreciation, and in the case of the electric vehicles, maintenance of accumulators.

The Microscope in Engineering Work.

THE Royal Testing Laboratory at Charlottenburg is constantly doing good work in connection with the properties of the various materials of construction used in engineering, and its transactions, which appear at irregular intervals throughout the year, contain much that is of value in practical work.

In a recent issue of the *Mittheilungen* of the institution the subject of the use of the microscope in connection with the study of the physical constitution of metals is discussed, and the views of the Director, Professor Martens, and also of Professor Heyn, are given in a excellent illustrated paper.

Although the microscope has long been considered of value in certain lines of engineering work, it is only in the hands of trained observers that direct results of value can be obtained, but when the microscope is used in connection with the camera, permanent records may be secured which have a lasting value for purposes of study and comparison, which is only beginning to be appreciated.

The best results in this line of work can only be obtained by the use of special apparatus and the micro-photographic camera devised for use at Charlottenburg, by Zeiss, of Jena, is illustrated and described as a satisfactory model for study and imitation. This apparatus is arranged for use in either the vertical or horizontal position, and includes many auxiliary devices for use in handling and illumination which have been developed in the course of experience at Charlottenburg.

The most extensive use which has been made of photo-micrography has been in connection with the study of metallography, or the physical character of metals as revealed by the action of etching solutions upon polished surfaces, but in many instances very instructive results have been obtained by polishing sections of the metal and photographing the enlarged image without etching in connection with such oblique illumination as will best bring out the unequal abrasive action upon the constituents of varying hardness.

The paper gives a tabulated account of examinations of a number of specimens, with photo-lithographic reproductions of the results, showing very clearly the extent to which this method may be used to reveal the character of the metal under consideration. In some cases the same subject was photographed both in the ordinary manner, and with an orthochromatic plate, the advantages of the latter being evident in certain instances. The most satisfactory source of illumination was found to be the oxy-hydrogen light, using illuminating gas in place of pure hydrogen and a pencil of magnesia instead of a lime cylinder.

Among the illustrations may be mentioned drawings of the conveniently arranged dark-room used at the laboratory, while the paper contains much valuable information about the special objectives found most valuable for the work.

Taken in connection with what has already been published upon the science of metallography, this paper upon the practical side of the work will be welcomed by engineers elsewhere who are engaged in the study of materials of construction.

REVIEW OF THE AMERICAN PRESS

Steam Engineering in the United States Navy.

IN view of the remarkable work which has been done by the various vessels of the United States Navy during the past two years, the report of the Engineer-in-Chief, Rear-Admiral George W. Melville, is a paper worthy of especial mention at this time.

The year which is covered by the report has been one in which it was expected that many important lessons would be learned, since the cessation of hostilities made it possible to proceed with the repairs and reconstruction work which active service had made necessary. It is a most reassuring evidence of the excellent character of the work on the various vessels to learn that no desirable change in the machinery has been found advisable, with the exception of an increased capacity of the evaporating plants, and the adoption with all practical and economical promptness, of the water-tube type of boilers. The importance of providing ample capacity in the evaporating plants follows of necessity the adoption of water-tube boilers, since the damage resulting from the use of salt water in such boilers was fully demonstrated in the case of the boilers of the torpedo boats.

So far as the water-tube boilers themselves are concerned, the eminently wise policy has been adopted of progressing with such proper speed as is necessary to avoid mistakes and to obviate sacrifice of still useful boilers of the older type. The boilers under immediate consideration are the Babcock and Wilcox, several installations having been made of this type on existing vessels of which the Scotch boilers were worn out, and the Niclausse and Thorneycroft boilers for the battleships now building.

It is interesting to note that the present status of the water-tube boiler is regarded by the Bureau of Steam Engineering as depending more upon protection from deterioration when not in use than upon efficient output during actual service. There seems to be no question as to the value of the water-tube boiler as a rapid and efficient generator of high-pressure steam, nor of its ability to stand hard forcing in time of emergency. The real question lies in the preservation of the boilers during the years of ordinary naval service which do not call for more than a very limited use of the entire plant. This feature has often been ignored by designers of water-tube boilers, and yet it forms one of the most important differences between land and naval service, and evidently demands careful study and consideration.

An interesting feature of the report is that portion which discusses the character of auxiliary machinery. The agitation which has been made in some quarters for the installation of electrical power-plants on shipboard from which all auxiliaries shall be operated by means of electrical motors, while doubtless having some good arguments for its support, has not found favor with the Bureau, and the conclusions of Mr. Melville in this matter appear to be eminently sound. When the difference in conditions on shipboard and ashore are considered it will be seen that the high economy attained in the machine shop by the use of electric driving can hardly be expected under the varying service on vessels. The improvement in the economy of steam auxiliaries has been such that excellent results are now obtained, so far as efficiency is concerned, and when, as is now commonly the case, the exhaust steam from the auxiliaries is either used to heat the feed water, or is discharged into the receivers of the main engines, the economy of the whole plant is found to be excellent. That the Bureau has no prejudice against electric driving in itself is plainly shown by the fact that it has been adopted altogether for the new shops at the New York Navy Yard now being constructed to replace those recently destroyed by fire.

Another line of work of the Bureau which is of interest to mechanical engineers is that of the drafting room, including the general preliminary work which must be continually made in order that the machinery of the vessels of the navy may be kept up to the constantly advancing standard of current international practice. Among the most important matters under consideration in this department may be mentioned the questions of best cylinder ratios for multiple-expansion engines, economical arrangements for using superheated steam, practical limit for true economy in forced draft, reduction of cost of horse power of auxiliary machinery by improved design, efficient heating of feed water by exhaust steam, and the still further improvement of the screw propeller.

In connection with the work of inspecting the materials and workmanship upon the vessels now under construction, it is gratifying to find that there has been great improvement in the manufacture of high-grade forgings, and the severe requirements for forgings of nickel-steel, either oil-tempered or annealed, have been very successfully met.

The practice of the Bureau of supervising with competent officers such tests and experiments as may prove of value to the department, has been continued, and among the tests upon which reports have been made may be mentioned trials of Babcock and Wilcox and Niclausse boilers, also tests of main and auxiliary machinery on the lake steamers Alexander McDougall and Pennsylvania, as well as of mechanical stokers on the latter vessel, while experiments on liquid fuel are still in progress.

The whole tenor of the report is to emphasize the essentially mechanical work of the Bureau, and demonstrate the mechanical character of nearly all the work on board a modern war ship. The manner in which the Chief refers to the mechanical nature of electrical engineering is of especial interest in this connection.

"The operation of electrical machinery is purely mechanical. That this may be done efficiently requires good mechanical ability at the generating engines. Electrical difficulties and casualties are almost always questions of mechanical engineering. I know that it conduces to the efficiency of the service, to the feasibility of a more extended use of electricity, and to an increase in the life of the electrical apparatus if the electrical plant were placed in charge of this Bureau. I desire to call attention to the fact that it is almost the universal commercial practice to place electric generating plants in the charge of mechanical engineers."

Piece-Work.

THE question of the best method of remunerating labor is receiving much attention at the present time, and it has become evident that in the midst of the changing methods of works-management the ancient method of measuring the value of a piece of work by the time expended in making it will have to give way to some more rational system, and that it must be practicable to arrange matters so that both employer and employee shall be benefited by the change.

An excellent discussion of one phase of this matter is found in a paper presented before the Western Railway Club by Mr. R. T. Shea, treating of the methods of piece-work in a railroad shop, and while the discussion relates primarily to railway practice in America, yet it is so broadly treated as to be of general interest and value.

Works managers are beginning to realize that the important matter is the actual money-cost of the finished product, not the absolute amount of wages earned by the workman. Low wages are by no means the cheapest, nor is the pay roll the only item of cost. The cheapest man is not the one who gets the least pay, but the one who makes the cheapest articles. The fixed charges of an establishment, usually amounting to as much as the pay roll, must be paid on a time basis, and hence the less the time expended on a piece of work the smaller the portion of the general expense-charge it must bear, and so the advantage of rapid production of an article is by no means limited to the saving of the workman's time. It must not be forgotten that the final transaction, *i. e.*, the sale of the article by the manufacturer to the customer, is always on a piece basis, the customer caring nothing for the amount of time spent on the article, but tendering only a fixed piece-price for it.

The method of paying workmen by the day is really a survival from ancient times, probably originating in pastoral and agricultural countries, where the value of the labor of all the men engaged in such simple occupations was practically uniform, and in which time was doubtless a fair measure of it. When the skilled mechanic appeared, he was at first an individual workman doing all by himself, and dealing directly with his customer, and so necessarily earned his pay on a piece basis, being practically in business for himself. When, still later, the employer of mechanics appeared, he used the only process of paying for labor known to anyone, *i. e.,* the day wages, notwithstanding the contradictory relation which appeared between time for production and selling price of product, and ever since that time the attempt to reconcile the contradiction has been continued.

The introduction of the piece work system is practically a return to the idea that every mechanic should be in a sense in business for himself, the only real reason for his association with other workmen under one employer being the necessity for centralization in order to secure the advantages of power-operated machinery. Under the piece-work system the employer no longer holds the old relation of master over a body of servants, he is rather a jobbing customer of a number of mechanics in business for themselves.

The great defect in this apparently ideal method lies in the fact that this wholesale employer-customer too often takes advantage of his position to attempt to force prices down below the stimulating rate until they reach the discouraging point. The true advantage of piece-work is that it encourages the workman to do his best, its weak point lies in the fact that it is too often abused into discouraging him in the struggle.

Many employers cannot get rid of the old day's-work fetich after they have introduced the piece-work system, and persist in comparing the earnings of the men under piece-work with what was formerly considered the "going-rate" by the day. Instead of watching to see that the workman does not make very much more by piece-work than he formerly did by day-rate, the manager ought to devote his attention to the cost of the product, as compared with its former cost. The only conception of reducing cost under the old system was the lowering of wages, and the old-time manager cannot bear to see the workmen earning 40, 50, or 60 per cent. more than formerly, and so, without regard to the fact that his product is costing him far less than formerly, he thinks to himself that "these men are making too much," and the rate is forthwith cut. The result is either protest, resistance, or discouragement on the part of the men, and the system gets the blame due only to its abuse.

Mr. Shea gives many instances of the excellent working of the piece-work system in railway shops, showing how entirely satisfactory it may be made, both to employers and men, and in summing up he concludes:

"From both the manager's and engineer's point of view it is of value at the start, naturally progressive (a building-up process) and of almost unlimited possibilities in lowering the cost of production, increasing the organization, and rendering automatic the operation of a manufacturing works. Where it has failed it has failed because it has been totally misunderstood or misapplied.

Coaling Vessels at Sea.

Among the papers presented at the recent convention of the Society of Naval Architects and Marine Engineers was one of much interest by Mr. Spencer Miller, relating to the subject of coaling vessels at sea from colliers, without delay to the former or risk to the latter.

The importance of this subject was emphasized during the Spanish-American war by the difficulties encountered in laying colliers alongside, even in the quietest weather, and more than once serious disadvantages of position had to be temporarily permitted in order to enable coaling stations to be visited.

Mr. Miller calls attention to various propositions which have been made from time to time to transfer the coal over a cableway extending from the collier to the war ship, and shows that the great difficulty involved in the operation of a cableway as ordinarily constructed lies in the varying tension which must occur. It is necessary that one of the vessels be towed by the other, and for considerations of safety to the weaker vessel the distance between the two should not be less than about 200 feet. The cableway, however, must maintain its proper position above the water if the load is to be transferred safely, and this means that any slack occurring by reason of pitching or tossing must be instantaneously taken up, while any excess of tension must be as promptly relieved, otherwise the load may be dumped into the sea or the cable subjected to a stress sufficient to cause it to part.

Various attempts have been made to regulate the tension upon the cableway by means of counterweighting devices, and a coal transporter with such a device was made according to the plans of Hon. Philip B. Low, and tested by the U. S. Navy Department in 1893. It worked well enough in perfectly smooth weather to demonstrate that the conveying apparatus offered no great difficulties, but the counterweight device proved inadequate in rough water, and the trials were not continued. Attempts have also been made in the French navy to coal at sea from a collier provided with a Tremperley transporter, but though these were at first partially successful they were terminated by damage done to the collier. Still the great durability of providing some means of coaling when at sea has led the French Admiralty to attach such a collier permanently to the Mediterranean reserve squadron.

The plans suggested by Mr. Miller involve the use of a cableway extending from the war ship to the towed collier, but provide in a novel manner for promptly taking up slack or relieving tension. The first plan was to provide the collier with a sea anchor attached to a moveable sheave in the bight of the endless cable, the war ship thus towing the sea anchor, the collier merely supporting the strands as they passed over. Trials of this system were made on one-fourth scale by using a tug boat towing a sloop in New York harbor, and although the weather was quite rough the correctness of the principle was fairly well demonstrated. A modified arrangement has now been placed on the U .S. collier Marcellus, and sea trials are expected to show the capabilities of the apparatus.

In the later form the collier is provided with a specially contrived winding engine, having two drums, both acting to wind in the two ends of the cable, the bight of which passes about a sheave on shear poles on the towing war ship. The two drums are provided with tension devices, the one maintaining a constant tension of 3,000 pounds, the other with a tension which may be varied between 1,000 and 4,000 pounds. The cable will always travel towards the drum of greatest tension, and hence by varying the tension on the one drum the carrier may be caused to travel to and fro as may be desired, while at the same time both drums take up very rapidly any slack which may be caused by pitching of the vessels. It is evident that the tension on the cable can under no circumstances exceed the frictional slipping resistance of the drum, and thus the working conditions appear to be well met.

If practical experience with this apparatus fulfills reasonable expectations one of the most difficult problems which has appeared in connection with the engineering side of the development of sea power will have been solved, and a freedom in naval tactics permitted to a extent hitherto not possible.

The Fuel Economy of Railroad Engines.

It is beginning to be recognized that the service required of power-house engines for tramways is of such a special character as to render it necessary to consider them in a class by themselves, and for this reason the paper presented by Professor R. C. Carpenter to the New York Street Railway Association is of much value at the present time. The paper consists of a discussion of the fuel economy of various kinds of steam engines, based upon tests made upon thirty-five different plants, and the results are so classified as to show the fuel consumption of several classes when operating under the usual conditions of power-house work.

The principal feature of power-house work for tramways is the very variable character of load, making it necessary to provide an engine capable of meeting the maximum demand which may come, and therefore operating under an average load much below that of greatest economy. The direct effect of this average underloading is to reduce the economy of the engine from 20 to 40 per cent. of that obtainable when working under the most advantageous uniform load.

The tests included non-condensing slide valve and Corliss engines, and also compound engines, condensing and non-condensing, of the single and the four valve automatic types, and the results are tabulated both with respect to the steam and coal consumption. From these tables much interesting information may be obtained, not only with respect to the relative economy of the different types of engines, but also with regard to the broad question of the cost of a steam horse-power.

Taking the steam consumption per horse-power-hour as the fairest basis of comparison we have the following general results. For the plain slide-valve engine, non-condensing, the steam consumption averaged 34.3 pounds, and this was reduced to 22.7 pounds for the compound condensing engine. The consumption for the simple Corliss engine averaged 28.3 pounds, or 18.2 pounds when operated compound-condensing. These figures when compared with the performances of similar engines operating under the most favorable conditions show that the irregular loading of power-house work causes the economy to be affected adversely by 30 to 40 per cent. for the slide-valve engines, and about 20 per cent. for engines of the Corliss type. The best result obtained with a compound condensing Corliss engine was a consumption of 14.5 pounds of steam per horse-power-hour, and this was with an engine of 2,000 horse-power.

The question of original first cost of plant is also considered, and for purposes of comparison the figures are given for a plant of 500 h. p. This comparison reveals the fact, which has not been sufficiently emphasized heretofore, that the diminished boiler capacity required by the more economical engine nearly makes up for the increased cost of the engine, the simple non-condensing Corliss engine plant being given at $15,100 while the compound condensing Corliss plant is put at $16,625. The cost of a steam horse-power per year, including fuel and interest, but not including labor and oil, and taking coal at $2.00 per ton, and the day at 18 hours, ranges from $32.71 down to $14.46, the average for the compound condensing Corliss engine being $18.12.

In summing up, Professor Carpenter says: "These figures show that no station can afford to purchase and operate the simple non-condensing engine of any type as compared with the compound-condensing engine. The compound-condensing engine of the best type and with improved valve gear, although costing somewhat more, is so much more economical to operate, that, taking all things into consideration, it gives much better financial returns than an engine of any other class. These financial returns are so much in their favor that unless other conditions are exceedingly unfavorable these latter engines are the only ones which should be considered in purchasing machinery for power-house work. This general conclusion, that the compound-condensing engine of slow rotative speed and with improved valve gear is much more economical than any other type for power-house work, even when fixed charges are considered, is certainly the only one which can be adopted from the results of the tests."

Erecting Appliances for Shipyards.

THE extending use of mechanical appliances for handling as much as possible of the work formerly performed by human effort, is not confined to the machine shop and factory, but is to be observed also in the more modern shipyards, and the best present practice includes the use of portable tools, operated by power and supported by cranes, or similar appliances wherever possible.

Some of more extensive plans for use in shipbuilding are described in a paper presented before the Society of Naval Architects and Marine Engineers by Mr. James Dickie, and a brief notice will be of interest. Previous to 1884 the derrick-pole with swinging gaff was the only means in general use, but this has since been followed, by various forms of cantilevers, gantries, etc.

A good example of the cantilever is seen in the yards at Newport News, but this has its limitations. It only performs one of the four functions, of hoisting, carrying operative tools, erecting staging, and keeping upper works fair, and as there is only one crane to two ships it is difficult to see how it can do all the hoisting for one vessel since the time of hoisting and travelling is such a small part of the work. The average hoist takes about forty seconds, traveling to destination about 55 seconds, while it takes from seven to twelve minutes to get sufficient bolts in a shell-plate or beam to enable the crane to be let go.

On the lakes the overhead gantry is used, traveling on rails on the ground on each side and covering the whole of the vessel. Two cranes are used for one vessel, and as the vessels are built broadside to the water the cranes are simply run to each end at the time of the launch; but these can only do the hoisting.

At the yards of Harland & Wolff, at Belfast, the large gantry, about which much has already been written, was constructed for use in the building of the Oceanic. This machine performs both the functions of hoisting and riveting, but its operation appears to be limited by the fact that it cannot cover more than 120 to 150 feet in length of the vessel at one time, and its size and weight must render it slow in operation.

The plan advocated by the writer is that of a framework covering the entire vessel while building. This is in use at the yards of Messrs. Swan & Hunter, on the Tyne, and at the Union Iron Works, at San Francisco, and is the most complete arrangement of all, as it enables all four functions to be fully performed. Overhead traveling cranes cover the entire area of the vessel, while jib cranes on both sides beneath these are used for carrying riveting machines and other tools. A 50-foot jib crane at each end enables work to be done on a vessel 100 feet longer than the framework structure, and operations can be carried on on all parts of the vessel at the same time.

At the Union Iron Works there are four of these structures, three of them being 300 feet long, and one 408 feet; the latter being large enough for a vessel 500 feet in length, by reason of the jib cranes at the ends.

The greatly increased advantage which such complete methods of handling materials and introducing portable mechanical tools, such as hydraulic and percussion riveters, drills, caulking tools, etc., gives to the establishments so equipped, must compel others to devise similar methods of work, and a marked reduction both in time and cost should be the general result.

The Purification of Water by Ozone.

SEVERAL months ago there was noticed in these columns the process of MM. Marmier and Abraham for the sterilization of drinking water by the use of ozone, with especial reference to the installation at use in the city of Lille, in France, the success of the process, so far as sterilization was concerned, seeming to be very effectively accomplished. We now have a paper upon the same subject by Mr. George A. Soper, prepared at Columbia University, New York, and published in *Engineering News,* not only reviewing the various French experiments, but also discussing his own investigations.

After briefly noticing the nature and methods of production of ozone in the laboratory, and showing that its value lies in its powerful oxidizing action, Mr. Soper goes on to describe the work of Tindal at Amsterdam, upon water taken from the Old Rhine at Oudshoorn, and upon Seine water at Paris. Experiments have also been made by Ohlmueller upon Spree water at Berlin, and the Tindal apparatus was tested at the Brussels exposition. In most of these cases the water was purified by sand filtration before the ozone treatment was applied, but the experiments of Ohlmueller were made upon unfiltered water from the Spree and upon distilled water to which known amounts of impurities were added. These tests showed that both the river water and the prepared samples were completely sterilized by the ozone in a few minutes, while sewage appeared to resist the action of the oxidizing agent.

The tests on the large scale in Europe were very successful, so far as the destruction of the bacteria was concerned, but the fact that the solid organic impurities had been previously removed by the filtration, renders these installations only partially conclusive.

Some few figures are given in this connection as to the cost of purification by ozone, although fuller data in this respect would be welcome. In connection with the Paris tests, Dr. Repin, of the Pasteur Institute, says that where the water does not contain more organic matter than is represented by 0.004 gramme permanganate per litre, 5 cubic metres may be purified by the expenditure of 600 watts, this corresponding to about 0.6 h. p. per 1,000 gallons. Similar data at Brussels make the required energy about 0.5 h. p. per 1,000 gallons, and it was estimated that the cost of ozonizing water containing 0.1 gramme of organic matter per litre was less than 1 centime per cubic metre.

The experiments made by Mr. Soper, while conducted only on a laboratory scale, contribute some valuable information on the same lines as the larger experiences in Europe. These tests, of which a detailed account is given in the paper, included the removal of color and odor from various prepared samples, and also the treatment of Croton water with a view of determining the extent to which bacteria were removed. So far as odors and discolorations are concerned, the results were eminently satisfactory, the ozone removing all odor and nearly all discoloration from samples much more offensive than would be met in any water offered for drinking purposes. The bacteriological investigations, while not as conclusive as might be wished, gave interesting results, and showed that treatment of 15 to 20 minutes removed about 87 per cent. of the bacteria present. The chemical analyses of Croton water showed a notable degree of purification, and under the action of ozone nitrites disappeared, albuminoid ammonia and free ammonia were oxidized, and a material reduction in color effected.

The general conclusions as to the availability of ozone for water-purification are that by its use bacteria may be largely eliminated and unpleasant colors and odors removed. Since suspended matters are not removed nor destroyed, some form of filtration or sedimentation should precede ozonization, but such filtration need be only a simple straining.

The vital question of cost is not yet definitely determined, but some conclusions may be drawn from the figures given above.

Simplification of Battleship Construction.

One of the most important papers presented before the recent convention of the Society of Naval Architects and Marine Engineers was that by Mr. George W. Dickie, the well-known engineer of the Union Iron Works of San Francisco, dealing with the increasing complications in war-ships and suggesting how simpler arrangements might be adopted.

Everyone who has had to do with a modern war-ship has observed the enormous increase in complicated details, the proper working of which is essential to the serviceability of the vessel, and the care and supervision of which is a great burden upon the operating force. As is usual in such cases the arrangement of these details is not a matter possessing any unity of design, it is rather a growth, one thing having been added after another until the present crowded state of affairs has been reached, while the end is evidently not yet reached. Mr. Dickie believes that the present complicated condition is the result of two causes:

"First, uncontrolled growth of new devices for doing the many things for which mechanism is required on these vessels, without the new devices being considered reliable enough to supersede the old. Hence, duplication, and, in many cases triplication of apparatus for doing one thing, for which one good device alone should be used.

"Second, the system of divided control over the work, rendering it impossible to have a homogeneous design to begin with, that would enable the ship and all that is required of her to be treated as one machine, and provision made at the start for every function being considered with relation to every other function."

In discussing the best methods for overcoming the present excessive complication Mr. Dickie is recording only certain ideas which have occurred to him in his own struggles with the prevailing tangled condition of affairs, and disclaims any desire to propose any system of management in the construction of ships for the navy; but his ideas are undoubtedly of such value as to merit the careful consideration of marine constructors.

The principal suggestion made by Mr.

Dickie is that of providing a main tunnel or passage way, placed near the axis of the vessel and extending without obstruction from the chain lockers forward to the steering room aft, this tunnel to contain all the pipes, wires, and communicating mechanism of the ship. Such a tunnel would constitute the spinal cord of the vessel, and from it light, heat, power for auxiliaries, air, and orders of every description would be delivered to every department, by lateral branches only. This passage would have to be protected by armor from possibility of damage in action, and to be perfectly safe without division by water-tight doors, and from its location would be removed as far as possible from danger by stranding or collision. If a central station is used it should be formed by widening the central passage where the armored tube enters the roof of the passage from the conning tower. By making this tube large enough, all the speaking tubes, telegraph wires, steering-gear shafts, etc., etc., could be arranged so as to permit of examination or removal without affecting the others. The wires, pipes, shafts, and other means of communication could then be carried from the station along the central passage to the points where they would enter the compartments where they belong, no opening being required in any of the transverse bulkheads, and everything being in sight.

Mr. Dickie is favorably inclined toward the use of electricity on shipboard, provided it can be made so reliable as to require no duplicate power in reserve in case of breakdown. As he pertinently says: "it should either be pronounced reliable, and depended upon, or abandoned."

Two other important features in which simplification is both desirable and attainable, are discussed in Mr. Dickie's paper, viz., drainage, and fire-service.

The present drainage system is the result of a growth from the old hand pump service up through the numerous modifications of steam pumps, either independent or connected to the main engines, which circumstances have seemed to demand. Each device has been added to the preceding one without superseding it and the result is a wilderness of pipes and connections. Mr. Dickie would do away with all this complicated arrangements, and substitute two longitudinal drainage mains, one on each side of the central bulkhead, requiring only two holes through the transverse bulkheads, and run branches from these mains to the double bottoms and compartments above, requiring to be drained. The drainage would be effected by single-lift jack-head pumps, in sets of three, operated by electric motors, such a number running constantly as would be found necessary, and maintaining a vacuum in the drainage mains, so that any part containing water could be immediately dried by opening the connection. This is the simple way in which an engineer would drain a battle-ship if he had never seen how it had been done before.

The fire service is at present mixed up with the drainage and feed pump systems, and there are innumerable sea-valves and connections of the usual complicated kind. Mr. Dickie proposes to consider the water supply of a ship as he would that of a factory or a town. Two salt-water pumps of a capacity equal to the greatest emergency demand, arranged with compound cylinders so as to be capable of economical operation at partial load, could be placed in the engine room and used to maintain a pressure of 40 pounds upon a salt-water pipe-system for all the ordinary service of the ship, while in case of fire service both pumps could be operated with high pressure steam in both cylinders, giving 120 pounds pressure in the mains. This system would require but two sea suctions, outside of those required for the main-engine circulating water, and all the old complicated arrangements would disappear.

Mr. Dickie's paper is a strong appeal for common sense in the internal arrangements of war ships, and while all may not agree with his conclusions, it is very apparent that the whole subject should be approached in a spirit of independence of the conservative prejudices which have so much to do with the present unsatisfactory condition of affairs.

The Engineering Index

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *qr,* a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Architectural Ironwork.

The American Exchange National Bank Building, New York. Illustrated description of the novel features in the skeleton of a 40 x 100 ft. office building, 16 stories high. 1100 w. Eng Rec—Oct. 14, 1899. No. 30203.

Ceilings.

Suspended Ceilings and Metallic Furring. Illustrated description of the construction of deep-paneled dome and arch ceilings with wire-cloth backing. 1500 w. Eng Rec—Oct. 7, 1899. No. 30101.

Tests of Ceilings (Probelastung von Decken). M. Gary. A report of tests made at the Government Testing Laboratory at Charlottenburg, with illustrations of the methods of loading. 1500 w. Mitt aus den Kgl Tech Versuchsanstalt—Part III. 1899. No. 30460 G.

Columns.

The Designing of Columns for Freight and Passenger Sheds Exposed to Wind. J. J. Pensoff. A mathematical study of the effect of the wind. 700 w. Eng News —Oct. 5, 1899. No. 30066.

Dewey Arch.

The Dewey Arch, New York. Illustrated description of the structural features and methods of construction of the arch and triumphal columns erected temporarily in Madison Square, West. 3800 w. Eng Rec—Sept. 30, 1899. No. 29986.

Exposition.

The Austrian Government Building at the Paris Exposition of 1900 (Das Oesterreichische Reichhaus auf der Weltausstellung, Paris, 1900). With elevation, plans and section of the building from the drawings of the architect, Herr L. Baumann. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 6, 1899. No. 30420 B.

The Progress of the Works on the Champ de Mars (Etat d'Avancement des Travaux du Champ-de-Mars). Ch. Dantin. With numerous views of the partly completed buildings, including the chimney of the great power house. 2500 w. Génie Civil—Sept. 16, 1899. No. 30400 D.

The Works on the Esplanade des Invalides, the Seine and the Trocadero (Etat d'Avancement des Travaux de l'Esplanade des Invalides, des Berges de la Seine et du Trocadero). Ch. Dantin. Reviewing the present condition of the numerous buildings, with many illustrations. 2500 w. 1 plate. Génie Civil—Sept. 23, 1899. No. 30402 D.

Fire Protection.

The Safety of Theatre Audiences. Wm. Paul Gerhard. Reprinted from the publications of the British Fire Prevention Committee. Discusses the features of the building upon which the safety of the people depends. 5800 w. Am Arch—Oct. 21, 1899. Serial, 1st part. No. 30-296.

Foundations.

Rapid Pneumatic Foundation Work. Illustrated description of wood caissons used in sinking piers for a New York building. 2200 w. Eng Rec—Oct. 28, 1899. No. 30394.

High Buildings.

The Highest Office Building in the World. Interesting features in the equipment of the Park Row Syndicate Building, in New York, are noted and illustrated. 2500 w. Engng—Sept. 22, 1899. No. 29963 A.

Pagoda.

Building an Indian Pagoda. J. Donnan, in *Indian Engineering*. A description of the work, with illustration. 2300 w. Stone—Sept., 1899. No. 29919 C.

Roof Trusses.

The Scissors Truss. F. E. Kidder. Illustrated discussion of the principles to be followed in designing them. 1100 w. Eng Rec—Oct. 7, 1899. No. 30103.

Stables.

A Suburban Stable and Casino. Illustrated description of a stable in the suburbs of Philadelphia which not only accommodates the horses and cows, but is fitted with living rooms for the employés, billiard and card rooms, bowling alley, amusement hall and musical studio. 2200 w. Eng Rec—Oct. 7, 1899. No. 30102.

Steeples.

The Computation of Octagonal Pyramidal Towers (Die Berechnung Achtseiliger Turmpyramiden). H. Müller-Breslau. A very complete mathematical treatment for the construction of steeples of framed structural metal, with diagrams showing the best methods of framing and bracing. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1899. No. 30-423 D.

Tenements.

Tenement House Requirements in New York. Plan of required and recommended construction to secure better ventila-

We supply copies of these articles. See introductory.

tion and light, with editorial note. 200 w. Eng Rec—Sept. 30, 1899. No. 29992.

Underpinning.

Underpinning Without Supports. Illustrates and describes the method of supporting a heavy wall, 94 feet high, carried less than 5 feet below the curb line, while an adjacent lot was excavated 9 feet below its footing. 1500 w. Eng. Rec—Sept. 30, 1899. No. 29991.

HEATING AND VENTILATION.

Ceiling.

The Form of Ceilings in Connection with Ventilation, Heating, and Acoustics (Die Form der Saaldecken in ihren Beziehungen zur Luftbewegung, Heizung, und Akustik). H. C. Nussbaum. A general discussion of the problems involved. 1200 w. Gesundheits-Ingenieur—Sept. 15, 1899. No. 30445 B.

Church-Heating.

The Heating of Churches, Especially the Heating of the Cathedral of Ulm. (Ueber Beheizung von Kirchen, insbesondere über die Beheizung des Ulmer Münsters). Prof. Rietschel. A very complete account of the introduction of low-pressure steam heating into a mediæval cathedral. Two articles, 6000 w. Gesundheits-Ingenieur. Sept. 15, 30, 1899. No. 30444 each B.

Furnace Heating.

Furnace Heating. William G. Snow. Illustrated detailed description. 2700 w. Met Work—Oct. 7, 1899. Serial, 1st part. No. 30059.

Heating Plant.

Some Interesting Details of a Heating Plant. Illustrated description of the plant for heating a number of large detached buildings at East Cambridge, Mass.; the central station consists of two engine houses and a boiler plant, all in detached buildings. 1000 w. Eng Rec—Oct. 14, 1899. No. 30204.

High Pressure.

The Disfavor Shown by Fire Insurance Companies to High Pressure Heating Apparatus. A. E. Grindrod. Read before the British Inst. of Heat and Ven. Engs. Considers the causes of disfavor and how to remove them. Also discussion. 3000 w. Heat & Ven—Sept., 1899. No. 29945.

House of Representatives.

Ventilation of the Hall of the House of Representatives and the South Wing of the Capitol, Washington, D. C. From a report of S. Homer Woodbridge. Discusses the advantages of upward and downward ventilation, favoring the upward system. Ill. 9500 w. Heat & Ven—Oct., 1899. Serial, 1st part. No. 30398.

Institution.

Heating and Ventilating St. Joseph's Home, Troy, N. Y. Describes a combination system of direct and indirect hot water radiation with some use of direct-indirect. Ill. 1500 w. Heat & Ven—Oct., 1899. No. 30397.

Residence.

A Hot-Water Furnace for Heating a Residence. Illustrated description of a furnace which supplies both hot water and warm air. 900 w. Eng Rec—Oct. 28, 1899. No. 30396.

Walls.

The Construction of Walls and Ceilings with Regard to Their Influence on Warming (Die Bauart der Wände und Decken in ihrem Einfluss auf die Heizung). H. C. Nussbaum. Showing the influence of walls upon the efficiency of heating apparatus. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1899. No. 30446 B.

Warming.

Practice in Warming (Aus der Heizungspraxis). F. Halbig. Discussing especially the most desirable features of boilers for steam heating. 2000 w. Gesundheits-Ingenieur—Oct. 15, 1899. No. 30447 B.

PLUMBING AND GAS FITTING.

Gas Fitting.

Pointers on Practical Gas-Fitting. Calls attention to important things in properly fitting a house. 1300 w. San Plumb—Oct. 2, 1899. Serial, 1st part. No. 30060.

Residence Plumbing.

An Elaborate System of Residence Plumbing. Illustrates special features in an unusually expensive New York residence. 4000 w. Eng Rec—Oct. 21, 1899. No. 30290.

Sanitation.

Domestic Sanitation. W. Watkins. Read at Sanitary Inspectors' Conference, England. A discussion of appliances in common use, and ways in which they should be improved. 3500 w. Plumb & Dec—Oct. 2, 1899. No. 30156 A.

MISCELLANY.

Estimating.

Estimating. John Lyman Faxon. Gives illustrations of estimating and discusses the proper basis. 2000 w. Br Build—Oct., 1899. No. 30377 C.

Public Health.

Engineering and Architecture. James Lemon. Discusses those branches which particularly affect public health, as pure water, sewerage, pure air, healthy dwellings, etc. 4500 w. Jour San Inst—Oct., 1899. No. 30292 F.

CIVIL ENGINEERING

BRIDGES.

Albany Bridge.

The Maiden Lane Bridge, Albany, N. Y. Illustrated description of a double-track bridge of one draw span 269 ft. long, four fixed spans of 181½ ft., and plate-girder approaches, designed to carry the heaviest trains of the New York Central line without checking speed. The type of construction differs in a number of respects from usual practice. 2700 w. Eng Rec—Oct. 28, 1899. No. 30389.

Arch.

The Arch. A statement of the development of the theory of the arch of masonry and metal. 1000 w. Eng Rec—Oct. 28, 1899. No. 30386.

The Development of the Arch Principle. Discusses the principle of the arch in its relation to metallic structures, citing examples and considering their merits. 2200 w. Engr, Lond—Oct. 6, 1899. No. 30229 A.

Atbara.

The Soudan Railroad and the Atbara Bridge. Extracts from the speech of Lord Kitchener at the opening of this bridge. 800 w. R R Gaz—Sept. 29, 1899. No. 29939.

Bridge Design.

Wheel Concentrations and Fatigue Formulas in Bridge Design. Continued discussion. 4400 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30353 E.

Hinged Arch.

Comparison of Weights of a Three-Hinged and a Two-Hinged Spandrel-Braced Parabolic Arch. Henry S. Jacoby. Continued discussion of paper by C. W. Hudson. 2000 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30352 E.

Philadelphia.

The Eighteenth Street Bridge, Philadelphia. Illustrated description of the details of a heavy plate-girder bridge over a railway subway. 1000 w. Eng Rec—Oct. 14, 1899. No. 30191.

Plate-Girder.

A Long Double-Track Plate-Girder Span. Illustrated description of a bridge 116 ft. long, carrying express trains at full speed on a curved track. 1500 w. Eng Rec—Oct. 21, 1899. No. 30278.

Protection Walls.

Concrete Protection Walls for Bridge Supports. An illustrated description of the protection against dislodgement by derailed cars furnished for the depressed tracks in Chicago. 600 w. Ry & Engng Rev—Oct. 14, 1899. No. 30211.

Reinforced Concrete.

A Concrete and Iron Bridge at Oconomowoc, Wis. Illustrates and describes a small, but interesting, arch bridge of this type. 700 w. Eng News—Oct. 19, 1899. No. 30255.

An Early Design for a Long-Span Concrete-Steel Arch Bridge. Thomas C. Clarke. Brief illustrated description of a design once accepted for the Washington Bridge over the Harlem River, in New York City. 400 w. Eng News—Sept. 28, 1899. No. 29956.

Timber.

The Life of Timber Employed in Railway Bridges in the United States. Tabulated report presented at convention of Assn. of Ry. Supts. of Bridges and Buildings. 400 w. Eng News—Oct. 26, 1899. No. 30372.

Trestle.

The Thomson Run Bridge. Brief description, with engravings, of a fine trestle bridge on the line of the Monongahela St. Ry. Co. 200 w. R R Gaz—Oct. 6, 1899. No. 30083.

Viaduct.

Floor Details of a City Viaduct. Illustrated description of a shallow floor system with special protection against gases from locomotives passing below. 1000 w. Eng Rec—Sept. 30, 1899. No. 29990.

CONSTRUCTION.

Foundations

See Architectural Engineering, Construction.

Groined Arch.

The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume. Continued discussion of paper by Leonard Metcalf. 2000 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30351 E.

Reinforced Concrete.

Computations for Ribbed Beams of Iron and Concrete on the Hennebique System (Berechnung der Gerippten Betoneisenträger, System Hennebique). Max R. v. Thullie. A mathematical treatment of the proportions for concrete girders with imbedded iron rods. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 15, 1899. No. 30416 B.

Retaining Walls and Bridge in Reinforced Concrete on the Quai Debilly (Murs de Soutenement et Pont en Béton Armé du Quai Debilly). Showing the practical application of the Hennebique system to an important piece of retaining wall construction at the Paris Exposition. 1200 w. Génie Civil—Sept. 30, 1899. No. 30406 D.

See Civil Engineering, Bridges.

Retaining Walls.

Computations for Retaining Walls (Calcul des Murs de Soutènement). S. Pichault. A very complete mathematical treatment of the pressure of earth upon retaining walls for various surchargings; with bibliography of authorities. 15000 w. Mem de la Soc Ing Civ de France—Aug., 1899. No. 30466 G.

Experiments on Earth Pressure Against Retaining Walls. A. A. Steel. Abstract of a graduating thesis at the University of Nebraska. An account of experiments to determine facts. Ill. 3000 w. Eng News—Oct. 19, 1899. No. 30260.

Roof Trusses.

See Architectural Engineering, Construction.

Similar Structures.

Similar Structures and Machines. Archibald Barr. Read before the Inst. of Engs. and Shipbuilders in Scotland. Recalls principles brought forward in a paper read in 1875 by James Thomson, giving further illustrations and applying similar reasoning to questions involving kinetic as well as static actions. 3700 w. Engng—Oct. 13, 1899. Serial, 1st part. No. 30322 A.

Subway.

The Philadelphia Subway and Tunnel. An illustrated account of the work on the Pennsylvania avenue subway and tunnel, and the engineering problems met. 2800 w. Sci Am—Oct. 21, 1899. No. 30249.

Underpinning.

See Architectural Engineering, Construction.

Water Main.

Laying a 6-in. Water Main Across Havana Harbor. Howard Egleston. Describes the plan adopted. Ill. 1800 w. Eng News—Oct. 12, 1899. No. 30181.

Waterproofing Masonry.

Waterproofing Tunnel Masonry. A statement of the methods adopted for the New York rapid-transit tunnels, involving the use of felts and asphalt, brick and asphalt, or asphaltic concrete. 1400 w. Eng Rec—Oct. 28, 1899. No. 30391.

HYDRAULIC AND MARINE.

Breakwater.

The Marquette Breakwater and Duluth Ship Canal Piers. Illustrated description of the method of making, supporting and placing enormous blocks of concrete. 5000 w. Eng Rec—Oct. 28, 1899. No. 30390.

Canals.

Failure of Canal Bank. Illustrates and describes the collapse of an embankment in England, at Dudley Port. 1200 w. Engr, Lond—Sept. 22, 1899. No. 29978 A.

Mechanical Traction on Canals. Historical review of the various methods tried. 4000 w. Engr, Lond—Sept. 29, 1899. No. 30136 A.

Notes on the History of the Danube Canal at Vienna (Beitrag zur Geschichte des Weiner Donaucanals). A. Prokesch. A review of the improvements in the canalized arm of the Danube at Vienna since the early works in 1688. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1899. No. 30435 D.

The Canal from the Lake of Thun to Interlachen (Der Schiffahrtskanal vom Thunersee bis Interlaken). A very complete account of the correction works on the river Aar and the construction of a navigable water-way to Interlaken, with map and profiles. Four articles, 7000 w. Schweizersche Bauzeitung—Sept. 16, 23, 30, Oct. 14, 1899. No. 30431 each B.

The Dortmund-Ems Canal (Le Canal de Dortmund à l'Ems). G. Henry. A very full account of the engineering features of the canal, with numerous illustrations and drawings of the lift at Henrichenburg. 4500 w. 1 plate. Génie Civil—Oct. 7, 1899. No. 30407 D.

The Lubeck Canal. From *Ueber Land und Meer.* Illustrated description of this canal and the difficulties met in its construction. 1600 w. Sci Am Sup—Oct. 28, 1899. No. 30362.

Water Transport Between the North of France and Paris (A Propos des Transports par Eau entre le Nord et Paris). A. de Bovet. A discussion of the elements of the cost of the water transport and the best method of reducing it. 4000 4. Mem de la Soc Ing Civ de France—Aug., 1899. No. 30465 G.

Dams.

Lake Levels—Proposed Dam in the Niagara. George G. Wisner. Discusses the advantage and the methods. 3400 w. Marine Rev—Oct. 19, 1899. No. 30297.

Municipal Ownership at Austin, Texas. W. D. Hornaday. Illustrates and describes the serious condition of the great dam across the Colorado River. 1000 w. Elec Wld & Engr—Oct. 14, 1899. No. 30503.

Drainage Canal.

The Salient Features of the Chief Engineer's Annual Report of the Drainage Canal of the Sanitary District of Chicago for 1898. Isham Randolph. Ill. 5000 w. Jour W Soc of Engs—Aug., 1899. No. 30376 D.

Dredges.

New Russian Dredge. A description of the dredge for the Volga ordered by the Russian government, with report of tests. 3800 w. U. S. Cons. Repts, No. 564—Oct. 27, 1899. No. 30375 D.

Suction Dredge and Collector (Saugpumpenbagger mit Sammelbehälter). An illustrated description of the new dredge built for use in the port of Antwerp. 1200 w. Schweizerische Bauzeitung—Sept. 16, 1899. No. 30432 B.

Dry Docks.

Algiers Floating Dry Dock. A description of the floating structure being built at Sparrow's Point, Md. 900 w. Marine Rev—Sept. 28, 1899. No. 30028.

Four Immense Dry Docks—League Island, Mare Island, Boston and Portsmouth. Brief illustrated description. 1200 w. Marine Rev—Sept 28, 1899. No. 30026.

Filtration.

A Few Words Upon Water Filtration. H. W. Clark. Some results at Lawrence, Mass., are given. 2000 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30-049 E.

Relative Applicability of Sand and Mechanical Filters. George W. Fuller. Outlines the work and the evidence now available upon these two methods of purification, and emphasizes the necessity of studying each supply. Also discussion. 9000 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30046 E.

The East Providence Filter. Illustrated description of a mechanical filter plant, with a summary of the results of tests made during five months' regular operation. 800 w. Eng Rec—Oct. 21, 1899. No. 30279.

The Improvement of the Philadelphia Water Supply. Illustrated description of the filters recommended by the expert commission of 1899. 1000 w. Eng Rec—Oct. 7, 1899. No. 30098.

The Mechanical Filtration of Water. A review of experimental results obtained at Cincinnati by G. W. Fuller. 1800 w. Eng Rec—Oct. 7, 1899. No. 30099.

Ground Water.

The Removal of Iron from Ground Water. Illustrated description of several plants built in the U. S. for this purpose, with figures of the efficiency of their operations. 1300 w. Eng Rec—Sept. 30, 1899. No. 29988.

Harbors.

Proposed Harbor Improvements at Victoria, B. C. Map with explanation of proposed improvements, with cost and particulars. 1400 w. Can Arch—Oct., 1899. No. 30360 C.

The 1000-H. P. Ladder Dredge for the Vladivostock Harbor Improvement Work, Russia. Illustrated description. 700 w. Eng News—Oct. 5, 1899. No. 30067.

The Harbor of Dortmund and Its Traffic (Der Hafen von Dortmund und sein Bisheriger Verkehr). J. Riedel. A note concerning the traffic and handling facilities of the port of Dortmund considered in connection with the opening of the Dortmund-Ems Canal. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 29, 1899. No. 30419 B.

Lock.

The Floating Guard for the Lock of the Wien at Weidlingau-Hadersdorf (Der Schwimmrechen vor der Schleuse der Wienfluss regulirung in Weidlingau-Hadersdorf). Describing and illustrating the floating guard used to intercept floating driftwood and other matter. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 29, 1899. No. 30418 B.,,

Organisms.

Asterionella—Its Biology, Its Chemistry, and Its Effect on Water Supplies. George C. Whipple and D. D. Jackson. A discussion of the conditions of growth of this diatom, the manner in which it imparts an offensive odor to water, and the most effective method of destroying it. 7500 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30044 E.

Chlamydomonas in Spot Pond. Frederick S. Hollis and Horatio N. Parker. An illustrated account of an organism that imparts an unpleasant taste and odor to the water. 1500 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30045 E.

Organisms Which Cause Unpleasant Odors and Tastes in Water Supplies. W. T. Sedgwick. Remarks on micro-organisms and a review of work published by George C. Whipple on "The Microscopical Examination of Drinking Water." 4300 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30047 E.

Reinforcing Wells.

Reinforcing a Well by Galleries. An account of the method of driving tunnels through water-bearing strata at the foot of a well. 1100 w. Eng Rec—Oct. 7, 1899. No. 30100.

Reservoir.

Denver's Great Storage Reservoir. Brief illustrated description. 1200 w. Fire & Water—Oct. 28, 1899. No. 30399.

Rivers.

River Hydraulics. James A. Seddon. An outline of the methods and results of a systematic study of data taken on the Mississippi River and its tributaries. 5500 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30348 E.

The Improvement of the Mouths of the Volga. Brief account of the commencement of a series of improvements in the navigation. 900 w. Engr, Lond—Oct. 13, 1899. No. 30312 A.

Sea Wall.

The Dymchurch Wall and Reclamation of Romney Marsh. Edward Case. Read before the British Assn. Historical account, with description of the method of building up a foreshore. 1700 w. Engr, Lond—Oct. 20, 1899. No. 30519 A.

Water Purification.

Sedimentation Basins for Water Works. Wynkoop Kiersted. Illustrated description of a type of basin which has been found useful in clarifying muddy water. 1700 w. Eng Rec—Oct. 28, 1899. No. 30392.

The Purification of Drinking Water by the Use of Ozone. George A. Soper. Reviews the work done by investigators and gives an account of experiments by the writer. 6300 w. Eng News—Oct. 19, 1899. No. 30256.

Water Supply.

Albany's Water Supply, and That of Her Neighbors. James D. Featherstonhaugh, in *Albany Medical Annals.* On the pollution of the Mohawk and Hudson rivers and the need of securing water from other sources, or properly purifying it. 2400 w. San—Oct., 1899. No. 29983 D.

Report of the Commission on the Improvement of the Philadelphia Water Supply. A review of the report of expert engineers appointed to investigate the question and report on plan for immediate improvement and extension. 4000 w. Eng News—Oct. 5, 1899. No. 30068.

Some Difficulties in Obtaining a Water Supply. Willis J. Milner. Read at Buffalo meeting of the Am. W. Wks. Assn. An illustrated account of the supply at Birmingham, Ala. 800 w. Fire & Water—Sept. 30, 1899. Serial, 1st part. No. 30000.

Some Results of the Systematic Examination of the Water of Public Water Supplies. X. H. Goodnough. An account of this work in Massachusetts and the information gained. Also discussion. 7000 w. Jour N Eng Water Wks Assn—Sept., 1899. No. 30048 E.

The Improvement of the Philadelphia Water Supply. Illustrated review of a report by Rudolph Hering, J. M. Wilson and S. M. Gray on the possible sources of a supply, and recommending filtration of river water, with notes on the allowable consumption of water and the growth of cities. 3200 w. Eng Rec—Sept. 30, 1899. No. 29987.

The Reduction of Water Waste. Morris R. Sherrerd. Before the A. S. M. I. Describes the methods at Newark and gives their results. 800 w. Eng Rec—Oct. 14, 1899. No. 30199.

Water Rates. August Herrmann. Before the A. S. M. I. An analysis of the rates in cities over 80,000 population, showing the variation in the manner of making the charges, their amount, and outlining some of the reasons for the difference in prices. 2100 w. Eng Rec—Oct. 14, 1899. No. 30200.

Water Tower.

The West Arlington Standpipe, Baltimore. Illustrated description of a standpipe with a masonry protecting tower in which special attention was paid to the architectural effect of the completed structure. 700 w. Eng Rec—Sept. 30, 1899. No. 29989.

Weirs.

A Modification of Foote's Irrigation Excess Weir or Spillbox. Describes modifications recently made by W. Newbrough. 700 w. Eng News—Oct. 26, 1899. No. 30371.

The Latest Researches of M. Bazin upon the Flow of Water over Weirs (M. Bazin's Neuer Untersuchungen über den Abfluss an Ueberfällen). R. Siedek. A resumé of Bazin's paper in the *Annales des Ponts et Chaussées.* 3000 w. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1899. No. 30436 D.

MATERIALS.

Asphalt.

Asphalt and Related Hydro-carbons. J. Ohly. The nature and origin, deposits and interesting history of its use. 1400 w. Min Rept—Oct. 5, 1899. Serial. 1st part. No. 30154.

California Asphaltum. Arthur Lakes. Describes some of the principal deposits and the methods of refining and handling the mineral. 1500 w. Mines & Min—Oct., 1899. No. 30145 C.

Cement.

Hydraulic Cement for Reservoirs and Canal Works. Illustrates and describes work on the continent of Europe. 1100 w. Fire & Water—Sept. 30, 1899. No. 30001.

Hydraulic Cement in the United States. Describes the works of the James River Cement Co. 1500 w. Engr, Lond—Sept. 29, 1899. No. 30139 A.

The Effect of Salt Water on Cement. A. S. Cooper. Gives results of experiments showing conclusively the ill-effect of salt in gauging mortar. 1500 w. Jour Fr Inst—Oct., 1899. No. 30089 D.

The Elasticity of Portland Cement. Describes experiments made at Liverpool by W. L. Brown. 1800 w. Eng Rec—Oct. 28, 1899. No. 30395.

Variations in Volume of Portland Cement Mortars (Variations de Volume des Mortiers de Ciment de Portland). M. Considère. A communication to the French Academy giving the result of experiments made to determine the influence of the expansion of cement upon reinforcements of imbedded metal. 2000 w. Comptes Rendus—Sept. 18, 1899. No. 30437 D.

Concrete.

The Choice of Materials for and the Manufacture of Concrete for Engineering Work. Ira O. Baker. Extracts from advance sheets of the ninth edition of "A Treatise on Masonry Construction." 4800 w. Eng News—Sept. 28, 1899. No. 29957.

Forests.

Forest Management in Maine. Austin Cary. Discusses the methods and work of the forester. 8800 w. Jour Assn of Engng Socs—Aug., 1899. No. 29916 C.

Protective Coatings.

See Marine Engineering.

Seasoning.

The Rapid Seasoning of Wood by Electricity (La Sénilisation Rapide des Bois par l'Electricité). J. A. Montpellièr. A description of the Nodon & Bretonneau process, by which the sap is rapidly replaced by a preservative solution by means of an electric current. Three articles. 4500 w. L'Electricien—Oct. 7, 14, 21, 1899. No. 30485 each B.

Timbers.

Life of Bridge Timbers and Advisability of Protecting Same from the Weather. Extracts from a committee report presented at the Detroit meeting of the Assn. of Ry. Supts. of Bridges and Buildings. Ill. 1700 w. Ry & Engng Rev—Oct. 21, 1899. No. 30326.

Some Notes on Fireproofing and Preserving Timber. Sherard Cowper-Coles. Reviews various processes and experiments. 2800 w. Ind & Ir—Oct. 20, 1899. No. 30523 A.

MEASUREMENT.

Frameworks.

The Exact Design of Statically Indeterminate Frameworks—An Exposition of Its Possibility, but Futility. Frank H. Cilley. An examination of certain questions in connection with ideal frameworks, of practical importance because at the foundation of actual designs. Mathematical. 14800 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30347 E.

Stresses.

The Problem of Struts with Lateral Loads. B. W. Head. A mathematical study. 2200 w. Engr Lond—Sept. 22, 1899. No. 29975 A.

Vienna.

The Plan of Vienna at the Beginning of the XVIII. Century (Die Wiener Stadtpläne aus dem Anfange des XVIII. Jahrhunderts). S. Wellisch. An interesting comparison of old surveys with modern data, with a discussion of the mean errors of the earlier maps. Two articles. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 6, 13, 1899. No. 30421 each B.

MUNICIPAL.

Assessments.

Local Assessments. A statement of the results of an endeavor in Jersey City to proportion the cost of local improvements equitably on property-holders and the city at large. 1000 w. Eng Rec—Oct. 14, 1899. No. 30201.

Garbage.

Garbage Disposal and Street Cleaning. W. C. Woodward. Read before the A. S. M. I. An outline of the best methods of securing satisfactory results. 1100 w. Eng Rec—Oct. 14, 1899. No. 30198.

Garbage Disposal at Cincinnati. Describes the method of collecting the garbage by city employés and delivering it to a company for disposal by reduction. 700 w. Eng Rec—Oct. 14, 1899. No. 30205.

Garbage Disposal at Toronto, Ont. Illustrated description of the method of collecting and of the cremators built by the city. 1300 w. Eng Rec—Oct. 21, 1899. No. 30285.

Havana.

The Engineering and Sanitary Renovation of Havana under U. S. Military Government. Abstract of report by Gen. Ludlow of the extensive and excellent work, with editorial comment. 6000 w. Eng News—Oct. 12, 1899. No. 30183.

Municipal Improvements.

The Importance of Municipal Improvements. A statement by W. P. Lewis, in an address before the Am. Soc. of Munic. Imp. at the Toronto meeting, of the magnitude of public works in the U. S. 1000 w. Eng Rec—Oct. 14, 1899. No. 30192.

New Orleans.

Drainage and Sewerage of New Orleans. A. N. Bell, in the *Times-Democrat.* Historical account of work and its effect on public health. 7500 w. San—Oct., 1899. No. 29982 D.

Pavements.

Asphalt Fluxes. W. H. Broadhurst.

A report read before the A. S. M. I. of studies made at the Brooklyn municipal laboratory of the value of fluxes for bitumen employed in pavements. 1000 w. Eng Rec—Oct. 14, 1899. No. 30196.

Brick Pavements. L. M. Hastings. A statement before the convention of the A. S. M. I. of the results of an inspection of such work in a number of cities. 1100 w. Eng Rec—Oct. 14, 1899. No. 30193.

Pavements Between Street Railway Tracks. Charles H. Rust. Read before the A. S. M. I. Illustrated description of the construction employed by Toronto, Ont., where the tracks are built and owned by the city. 1300 w. Eng Rec—Oct. 14, 1899. No. 30195.

Paving Brick and Brick Pavements. H. J. March. Gives the history and progress of brick-making, and considers brick pavements, their cost, durability, etc. 10500 w. Jour Assn of Engng Socs—Aug., 1899. No. 29918 C.

Street Railways and Street Pavements. Summary of a report by a committee of the Am. Soc. of Munic. Imp. on the means of keeping pavements about tracks in repair. 2100 w. Eng Rec—Oct. 14, 1899. No. 30197.

The Life of Pavements. Review of a paper by G. W. Tillson on the relative destructive action of various agents, and the life to be expected of different paving material. 2600 w. Eng Rec—Oct. 21, 1899. No. 30282.

Wood Pavements in Indianapolis. M. A. Downing. A description of the creosoted wood blocks and the manner of laying them. Read before the A. S. M. I. 1000 w. Eng Rec—Oct. 14, 1899. No. 30194.

Public Baths.

Baths for the Poorest. W. R. Court. From a report on the baths proposed for Liverpool, dealing with the plans and methods of administration. 1800 w. Arch. Lond—Sept. 29, 1899. No. 30-120 A.

Reports.

The Tabulation of Municipal Statistics. Summary of a report to the Am. Soc. of Munic. Imp. on forms for giving municipal statistics in order that the figures of different cities may be comparable. 3000 w. Eng Rec—Oct. 14, 1899. No. 30202.

Sanitary Engineering.

Inaugural Address by Sir William Henry Preece. Full address discussing the principles of sanitary engineering. 8000 w. Jour San Inst—Oct., 1899. No. 30291 F.

Sanitation.

The Renovation of Havana. An account of the work done in cleaning the city during the first six months of American occupation. 3100 w. Eng Rec—Oct. 7, 1899. No. 30097.

Sewage Disposal.

Bacteriological Sewage Works at Hampton-on-Thames. An illustrated description of the works and system, with an account of the difficulties encountered. 1200 w. Engr, Lond—Oct. 20, 1899. No. 30518 A.

Experience with Bacteria Beds. A report to the Sanitary Institute on the water capacity, size of filtering material, and the influences on organic nitrogen. 2300 w. Eng Rec—Oct. 21, 1899. No. 30281.

Recent Crossness Experiments with Bacterial Sewage Treatment. Gives results of passing sewage intermittently through beds filled to depths of 4, 6, and 13 ft. with coke of the size of English walnuts. 3000 w. Eng Rec—Oct. 28, 1899. No. 30393.

Sutton Sewage Disposal Works. The bacterial process has been for some time in operation and an account is given of the results obtained and the manner of obtaining them. Ill. 2800 w. Engr, Lond—Oct. 13, 1899. No. 30313 A.

The Bacterial Treatment of Crude Sewage at Crossness. Conclusions concerning the experimental intermittent treatment of London crude sewage in the coke beds, as taken from the report of the London County Council. 4800 w. Engr, Lond—Oct. 20, 1899. No. 30515 A.

The Bacterial Treatment of Crude Sewage. Editorial on the methods used at various places and experiments made. 2200 w. Engng—Oct. 13, 1899. No. 30319 A.

The General Distribution of the Sewage of Paris (L'Emissaire Général des Eaux d'Egout de la Ville de Paris). E. Fourrey. A very complete account of the system by which all the sewage of Paris is delivered to the irrigation area below the city. Interesting data about reinforced concrete construction are given. 4000 w. Revue Technique—Sept. 25, 1899. No. 30413 D.

The General Distribution of the Sewage of Paris (L'Emissaire Général des Eaux d'Egout de la Ville de Paris). E. Fourrey. The second paper is devoted to the sewage pumping machinery and the purification beds. 2500 w. Revue Technique—Oct. 10, 1899. No. 30415 D.

The Septic Tank Process of Sewage Treatment at Exeter and Yeovil, England. Letter to the editor describing the process so successfully carried out, with brief history of the place. Ill. 3500 w. Eng News—Oct. 26, 1899. No. 30-374.

Street Lighting.

See Electrical Engineering, Lighting.

Streets.

Street Grades. Considers the importance of fixing grades while the territory is not built up, based on the situation now existing in New York. 700 w. Eng Rec—Oct. 28, 1899. No. 30387.

Tampico.

Water Works and Sewerage in Tampico. Gives a translation of advertisement for bids on work of estimated value of $800,000. 600 w. U. S. Cons Repts, No. 548—Oct. 9, 1899. No. 30085 D.

Wastes.

Disposal of Wastes from Country Homes. H. C. Patterson. Illustrates and describes inexpensive plans and methods. 400 w. Dom Engng—Oct., 1899. No. 30272 C.

MISCELLANY.

Education.

Sir Andrew Noble on the Best Education for Engineers. Inaugural address given at the City and Guilds Central Technical College, England. Presents the necessity of acquiring a sound general education, and the necessity of basing practical work on theoretical knowledge. 3800 w. Nature—Oct. 5, 1899. No. 30221 A.

Some Unrecognized Functions of State Universities. J. B. Johnson. Condensed from address on the occasion of inauguration as Dean of the College of Mechanics and Engineering of the Univ. of Wisconsin. 3500 w. Eng News—Oct. 26, 1899. No. 30369.

The Best Education for an Engineer. W. E. A. A critical review of the address of Sir Andrew Noble. 2500 w. Nature—Oct. 12, 1899. No. 30302 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Pacific Cable.

The Proposed Pacific Cable Routes. Harrington Emerson. A masterly comparison of the practicability, cost, working expense, commercial and political value and financial expectations of all the proposed lines. Urges that broad economic wisdom, not narrow nationalism, be followed in choosing a route. 6000 w. Engineering Magazine—Nov., 1899. No. 30494 B.

Space Telegraphy.

Observations on the Operation of Wireless Telegraphy on La Grande Duchesse. William Maver, Jr. Gives an interesting account of the work during the recent yacht races. 1500 w. Elec Wld & Engr—Oct. 14, 1899. No. 30500.

Wireless Telegraphy. John Trowbridge. A history of the new life of the transformer and its possibilities. Ill. 4000 w. Ap Pop Sci M—Nov., 1899. No. 30342 D.

Statute.

The Telegraph Act, 1899. Editorial discussion of the act passed in England, Aug. 9, 1899, explaining the nature of the alterations it is likely to effect. 3000 w. Engng—Sept. 22, 1899. No. 29966 A.

Telegraph Survey

The Pioneer Telegraph Survey of British Columbia. P. J. Leech. An interesting illustrated account of the work in connection with the line that was planned to extend through British Columbia and Alaska to Behring Strait, and continuing to St. Petersburg, Russia. 6800 w. B. C. Min Rec—Aug., 1899. No. 30057 C.

Telephone Fuse.

Fuses for Telephone Conductors (Schmelzsicherungen in Fernsprechleitungen). K. Strecker. Describing a system of fuses for the protection of telephone conductors from the currents of tramway systems. 3000 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30474 B.

Telephony.

Some Instances of Composite Transmission and Compound Telephony. Thomas D. Lockwood. Read at the Wilmington meeting of the Assn. of Ry. Telegraph Supts. Illustrates and describes various arrangements for the simultaneous transmission of two or more telephonic messages over the same wires, or for sending telegraphic and telephonic messages over the same lines at the same time. 3500 w. Elec Rev, N. Y. —Oct. 4, 1899. No. 30071.

Visual Telegraphy.

The Telectroskope (Das Telektroskop). A description of the invention of Jan Szczepanik, by which it is claimed that visual images may be telegraphically transmitted. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1899. No. 30424 D.

DISTRIBUTION.

Circuits.

The Systematic Arrangement of Circuits in an Electrical Plant. William Baxter, Jr. Suggestions and illustrated description. 2000 w. Am Mach—Sept. 28, 1899. No. 29927.

Nuremberg.

The Distribution of Electrical Energy at Nuremberg (Distribution d'Energie de Nuremberg). H. Martin. With numerous illustrations of the generating plant and a full account of the operation of this very successful installation. 3000 w. 1 plate. Génie Civil—Sept. 30, 1899. No. 30404 D.

Power Subdivision.

Electric Power Distribution and the Small Consumer. Dr. Louis Bell. Showing how electric distribution may become a corrective of the centralization due to steam, and giving examples from recent continental practice of the redistribution of industry. 3500 w. Engineering Magazine—Nov., 1899. No. 30495 B.

Transformer Losses.

Switching Device for Preventing Losses in Unloaded Transformers (Schaltvorrichtung zur Vermeidung der Leerlaufsarbeit in Unbelasteten Transformatoren). H. Müller. A device for throwing the primary or secondary circuit of a transformer alternately in or out automatically. 1000 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30472 B.

Wiring.

Interior Alternating Current Wiring. R. W. Lohmann. A résumé of the principles governing the drop in a conductor traversed by an alternating current, with editorial. 4000 w. Elec Wld and Engr—Oct. 21, 1899. No. 30275.

Protection of Interior Wiring from High Potential Currents. Warren B. Reed and Lyman C. Reed. Discusses the efforts made to solve this problem and shows what is needed. 2400 w. Elec Wld & Engr—Oct. 28, 1899. No. 30385.

ELECTRO-CHEMISTRY.

Atomic Weight.

The Relation of the General Properties of Elements to Their Atomic Weight (Ueber die Beziehungen der Allgemeinen Eigenschaften der Elemente zu deren Atomgewichten). W. Sander. A general review of the theory of Mendelejew and his followers, and its application to practical electrochemistry. 2000 w. Elektrochemische Zeitschr—Oct., 1899. No. 30480 G.

Electrolytes.

The Decomposition of Solid and Fused Electrolytes (Ueber die Zersetzungsspannung Fester und Geschmolzener Elektrolyte). C. C. Garrard. A preliminary report upon a number of investigations made at the Göttingen laboratory under the direction of Prof. Nernst. 1500 w. Zeitschr f Elektrochemie—Sept. 28, 1899. No. 30478 G.

Laboratory.

The Arrangement of the Central Laboratory of the Stolberg and Westphalia Company (Elektrolytische Einrichtung des Central-Laboratorums der Aktien-Gesellschaft zu Stolberg und in Westfalen). H. Nissenson. With plans of well-arranged electrolytic laboratory, and illustrations of apparatus. 2000 w. Zeitschr Elektrochemie—Oct. 5, 1899. No. 30479 G.

Metallurgy.

Progress in Electrometallurgy and Analysis (Fortschritte auf dem Gebiete der Elektro-Metallurgie und Analyse). Dr. H. Paweck. A very complete record of the work of the past few years, with bibliography. Five articles. 8000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept, 2, 9, 16, 23, 30, 1899. No. 30448 each B.

Some Recent Applications of Electro-Metallurgy to Mechanical Engineering. Sherard Cowper-Coles. Abstract of paper read at Dover meeting of the British Assn. Calls attention to the importance electro-metallurgy is taking in engineering works, and describes a few applications. Ill. 3000 w. Elec Rev, Lond—Sept. 22, 1899. Serial, 1st part. No. 30040 A.

ELECTRO-PHYSICS.

Batteries.

A Review of the Development of Primary Galvanic Batteries During the Last 25 Years (Rückblick auf die Entwickelung der Primaren Galvanischen Batterien während der Letzten 25 Jahre). An interesting historical contribution to electrical science. 3000 w. Elektrochemische Zeitschr—Oct., 1899. No. 30482 G.

The Chemical and Contact Theories. W. R. Cooper. From a book on primary batteries to be published shortly by the Elect'n Pub. Co. Considers the investigations of Volts, Kohlrausch, and others. Ill. 2800 w. Elect'n, Lond—Oct. 13, 1899. Serial. 1st part. No. 30330 A.

The Practical Limitations of Dry Batteries. Aims to correct the misleading descriptions given of the capacity and efficiency. 900 w. Elec Rev—Lond—Oct. 13, 1899. No. 30305 A.

The Relation Between Electromotive Force and Chemical Heat in Galvanic Elements (Ueber das Verhältniss Zwischen Elektromotorischer Kraft und Chemischer Wärme in den Galvanischen Elementen). T. Gross. An exhaustive discussion, comparing the results of a number of experimental investigations with the mechanical theory of heat. 5000 w. Elektrochemische Zeitschr—Oct., 1899. No. 30481 G.

Thermal Relations in the Voltaic Cell. W. R. Cooper. From a book soon to be published by *The Electrician.* Considers the constitution of the cell and discusses mathematically the thermal relations. 4200 w. Elect'n, Lond—Sept. 29, 1899. No. 30121 A.

Electric Waves.

Velocities of Electro-Magnetic Waves in Air and Along Wires. M. C. Gutton. Translation of a paper presented at meeting of the Société Internationale des Electriciens. Reviews discoveries and experiments. 1200 w. Elec Rev, N. Y. Oct. 18, 1899. No. 30245.

Thermoelectricity.

On Thermoelectricity in Certain Metals. Ludwig Holborn and Arthur L. Day. Gives results of investigations. 1300 w. Am Jour of Sci—Oct., 1899. No. 29937 D.

GENERATING STATIONS.

Alternating Generators.

Alternating Generators for Direct Service, Alton D. Adams. An explanation of the desirable features. 1200 w. Elec Wld & Engr—Oct. 7, 1899. No. 30108.

Batteries.

See Mechanical Engineering, Automobilism.

Chicago.

The Double-Current Generators and Polyphase Apparatus of the Chicago Edison Company. Homer E. Niesz. Illustrates and describes a complete equipment for the simultaneous generation of alternating and direct currents in the same machines, or the conversion of direct to alternating currents for high-tension transmission purposes and reconversion. 3500 w. Am Elect'n—Oct., 1899. No. 30113.

Converters.

The Design of Rotary Converters. H. F. Parshall and H. M. Hobart. Part first gives tabulated results of investigations, and introductory remarks to the subject of proper lines on which to design rotary converters. 2000 w. Engng —Sept. 29, 1899. Serial. 1st part. No. 30124 A.

Darwen, Eng.

Darwen Electricity Works. Illustrated description of an English installation. 3500 w. Elec Eng, Lond—Sept. 29, 1899. No. 30123 A.

Dynamos.

Application of the Dynamo. H. Richards, Jr. Considers briefly its connection with the electric railway and lighting purposes. 800 w. Yale Sci M—Oct., 1899. No. 30161 C.

Economies.

Notes on Power-Station Economies. Maurice Hoopes. Gives results of the writer's experience. 1400 w. Elec Rev, N. Y.—Oct. 11, 1899. Serial. 1st part. No. 30168.

Henrichsburg.

Steam Engines and Dynamos at the Heinrichsburg Canal Lift. Brief illustrated description of engines forming a part of the electric generating plant at a lift on the Dortmund-Ems Canal. 500 w. Engr, Lond—Oct. 6, 1899. No. 30230 A.

Isolated Plant.

The Isolated Plant of a Wholesale Grocer's Establishment. An interesting description of the plant of the Garrett Building, Chicago. It includes novel features for solving the problems of a wholesale grocer's business. 3000 w. Am Elect'n—Oct., 1899. No. 30114.

Power Houses.

Chicago Electric Railway Power Houses. Illustrations with brief descriptions. 1600 w. Elec Wld & Engr—Oct. 14, 1899. No. 30502.

Power Plant.

St. Cloud, Minn., Water Power Plant. F. W. Springer. Illustrated description. Gives an ingenious means of maintaining constant voltage. 1600 w. Elec Wld & Engr—Sept. 30, 1899. No. 29949.

Sandwich Islands.

Electrical Plants in the Sandwich Islands. Illustrates and describes the plants of the Hawaiian Elec. Co., Ltd., the Hilo Elec. Lgt. Co., Ltd., and the government plant on the Island of Oahu. 1000 w. Elec Wld & Engr—Oct. 7, 1899. No. 30105.

Snoqualmie Falls.

Snoqualmie Falls Power Plant. Illustrated description of a 10,000 H. P. hydraulic plant with novel features. 2000 w. Power—Oct., 1899. No. 29993.

The Snoqualmie Falls Transmission Plant: An illustrated detailed description. 2500 w. Elec Wld & Engr—Oct. 21, 1899. No. 30274.

Sparking.

Commutation and the Prevention of Sparking. Describes how commutation is effected, and gives methods of preventing sparking. Ill. 1400 w. Engr, U. S. A.—Oct. 1, 1899. No. 30070.

Waste.

Profitable Disposition of the Waste Product of a Power Plant. Considers some of the means of economizing and of utilizing seeming waste. 1800 w. Engr, U. S. A.—Oct. 15, 1899. Serial. 1st part. No. 30242.

Woburn.

Woburn, Mass., New Central Station. L. R. Wallis. Illustrated description of a distinctly modern lighting and power plant. 1600 w. Elec Wld & Engr—Oct. 28, 1899. No. 30383.

LIGHTING.

Arc Lighting.

Series Arc Lighting from Constant-Current Transformers. William Lispenard Robb. Read before the Am. Inst. of Elec. Engs. Describes the system of the Hartford Electric Light Co. 2500 w. Elec Rev, N. Y.—Oct. 11, 1899. No. 30169.

Artificial Lighting.

Herr W. von Oechelhaeuser on Progress in Artificial Lighting. An epitome of the inaugural address of the President of the German Assn. of Gas and Water Engs. On the recent advances in the lighting industries. 2800 w. Jour Gas Lgt—Sept. 26, 1899. No. 30079 A.

Incandescent Lamps.

Cost of Lighting by Incandescent Street Lamps. Alton D. Adams. Considers the conditions affecting the cost. 1500 w. Munic Engng—Oct., 1899. No. 29984 C.

Incandescent Lamp and Transformer Construction in America. Henry E. P. Cottrell. Discusses the factors that determine the "candleage" of a lamp, and the details of construction upon which the efficiency of the transformers depends. Ill. 3500 w. Engr, Lond—Oct. 13, 1899. Serial. 1st part. No. 30307 A.

Nernst Lamp.

The Forerunners of the Nernst Lamps. Etienne de Fodor. Translated and abridged from *Elektrotechnischer Anzeiger*. Historical review of predecessors. 2000 w. Elec Rev, N. Y.—Sept. 27, 1899. Serial. 1st part. No. 29922.

Search Lights.

See Marine Engineering.

Street Lighting.

Public Electric Lighting. A consideration of the best method and the cost of obtaining satisfactory service from private companies. 900 w. Eng Rec—Oct. 21, 1899. No. 30287.

MEASUREMENT.

Alternating.

The Measurement of Alternating Current Effects by the Three-Voltmeter Method (Zur Messung von Wechselstromeffekten nach der Drei-Voltmeter Methode). F. Niethammer. A mathematical demonstration, showing that the three-voltmeter method is independent of curve form or phase. 3000 w. Elektrotech Zeitschr—Oct. 5, 1899. No. 30476 B.

Converter.

Investigations Upon a Converter (Untersuchungen an Einem Umformer). K. Pichelmayer. Giving the results of a study of a rotary converter, when operated under a variety of conditions. 4500 w. Elektrotech Zeitschr—Oct. 5, 1899. No, 30475 B.

Frequency.

Frequency Measurement. A reprint of a portion of a paper read by W. R. Ayrton and John Perry before the Inst. of Elec. Engs. about ten years ago, considering this subject. 1800 w. Elec Wld & Engr—Oct. 14, 1899. No. 30504.

Losses.

The Separation of the Iron Losses in the Transformation of Alternating Currents (Ueber die Treuming der Eisenverluste bei Wechselstrom transformatoren). W. Peukert. A discussion of the methods of distinguishing between the extent of losses due to eddy currents and hysteresis in transformers. 3000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30468 B.

Methods.

Electrical Measurement. H. E. Wimperis. A statement of the most fundamental facts of how electrical quantities are measured. 1000 w. Automotor Jour —Sept. 15, 1899. No. 30050 A.

Resistances.

Progress in the Construction of Electrical Resistances (Fortschritte im Bau Elektrischer Widerstande). Dr. M. Levy. With numerous illustrations of improved resistance boxes in which strips of metal are used instead of coils of wire. 2000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30469 B.

POWER APPLICATIONS.

Auxiliary.

See Marine Engineering.

Carrier.

Electrically Driven Carrier System (Elektrisch Betriebene Aktentransportbahn). Illustrating a neatly designed carrier for use in business establishments, department stores, post offices, etc. 1000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30470 B.

Cranes.

Electric Travellers. Joseph Horner. Discusses the development and designs of electric travellers in England and America. 3500 w. Mech Wld—Sept. 29, 1899. Serial. 1st part. No. 30119 A.

Electrical Dredges.

American Electrical Dredges on the Volga River, Russia. Illustrated detailed description of these high-powered suction dredges. 3000 w. Elec Wld & Engr—Oct. 7, 1899. No. 30104.

Electric Power.

See Mech. Engineering, Automobilism.
See Mining and Metallurgy, Mining.

Elevator.

A Type of Heavy Electric Sidewalk Elevator. Illustrated detailed description of hoists of the Ivins Syndicate Building of New York city. 700 w. Eng News—Sept. 28, 1899. No. 29958.

Friction.

The Friction Losses of Induction Motors when Unloaded (Ueber die Leerlaufreibung von Induktionsmotoren). R. Braun. A mathematical investigation of the methods of measuring the friction losses when no external work is being done. 2500 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30471 B.

Induction Motors.

The Action of the Polyphase Induction Motor Graphically Explained. An analysis of the interaction of the currents and magnetizations produced. 7000 w. Elec. Wld & Engr—Sept. 30, 1899. No. 29951.

Kearsarge.

See Marine Engineering.

Machine Driving.

Electric Driving in Machine Works and Rolling Mills (Elektrischer Antrieb in Hütten und Walzwerken). O. Lasche. With especial reference to the driving of the mills for rolling copper rod and wire for the *Allgemeine Electricitäts-Gesellschaft* at Berlin. 4500 w. Stahl und Eisen—Oct. 1, 1899. No. 30-463 D.

Motive Power.

Small Motive-Power Selection. Alton D. Adams. Discusses the comparative advantages of electric motors, gas engines and steam engines. 1200 w. Am Arch—Oct. 14, 1899. No. 30207.

Motor Control.

See Street and Electric Tramways.

Motors.

See Street and Electric Tramways.

Printing Motors.

The Practical Application of Electric Motors to Printing Press Machinery. W. H. Tapley. Considers what is the best known motor and how it shall be applied. 7000 w. Jour Fr Inst—Oct., 1899. No. 30088 D.

Pumping.

See Mining and Metallurgy, Mining.

Sanitation.

Electricity for Sanitation at Havana. Illustrated description of a plant employing the Woolf electrical process for the production of hypochlorites from sea water. 1100 w. Elec Wld & Engr—Oct. 7, 1899. No. 30107.

Single-Phase Motors.

Some Notes on Single-Phase Motors, with Special Reference to the Heyland Motors. A. C. Eborall. Briefly discusses what takes place in single-phase motors during starting and running, and describes the fundamental principles and construction of the Heyland motors. Ill. 3200 w. Elec Rev, Lond—Sept. 29, 1899. No. 30122 A.

Steel Works.

An American Electric Power Plant at the Frodingham Steel and Iron Works, England. Illustrated detailed description. 7000 w. Jour Fr Inst—Oct., 1899. No. 30088 D.

Electric Power as a Factor in Steel Mills. Some of the appliances for handling the metal in its various stages are illustrated and described. The plant is that of the Illinois Steel Co., at South Chicago. 1600 w. Am Elect'n—Oct., 1899. No. 30115.

TRANSMISSION.

India.

Electricity in India. C. C. Townsend. On the advantages that would follow the development of electricity from natural sources. 1700 w. Nineteenth Cent—Oct., 1899. No. 30270 D.

Kalamazoo.

Kalamazoo Valley, Michigan, Transmission Plant. Edward James Hart. Illustrates and describes the plant and line. 1800 w. Elec Wld & Engr—Sept. 30, 1899. No. 29950.

Long Distance.

Mt. Whitney, Cal., Transmission Plant. Donald H. Fry. Illustrates and describes the interesting features of this hydraulic electric plant. 1800 w. Elec Wld & Engr—Oct. 28, 1899. No. 30384.

Paderno.

The Power Transmission from Paderno to Milan (Die Kraftübertragung von Paderno nach Mailand). Ugo Ancona. With numerous illustrations of the hydraulic and electric generating station, and of the transforming and distributing system. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1899. No. 30442 D.

Power Transmission.

The Kootenay-Rossland Power Transmission. An illustrated description of the sub-station at Rossland, and of the application of the power for mining purposes. 3500 w. Can Elec News—Oct., 1899. No. 30210.

MISCELLANY.

Address.

The Centenary of the Electric Current, 1799-1899. J. A. Fleming. Abstract of a lecture delivered at Dover meeting of the British Assn. A review of the chief conclusions reached after a century of investigation, and a discussion of the problems remaining to be solved in determining what is an electric current. 5000 w. Elect'n, Lond—Sept. 22, 1899. No. 30036 A.

Animal Electricity.

Animal Electricity. W. S. Hedley. Considers various electrical results of excitation and the theories advanced. 2800 w. Elec Rev, Lond—Sept. 22, 1899. No. 30038 A.

Commutator Tools.

The Construction of Some Handy Commutator Tools. Alton D. Adams. Describes simple and inexpensive tools of great service, and states requirements and methods used. 1800 w. Am Elect'n —Oct., 1899. No. 30117.

Electrographs.

Electrographs of the Electro-Static Current Made Without a Camera. Elmer Gates. Illustrated account of interesting experiments showing the path taken by the current. 1600 w. Sci Am—Oct. 7, 1899. No. 30072.

Smokeless Powder.

Electricity in the Manufacture of Smokeless Powder. Describes the government electrical plant at Indian Head. Ill. 1200 w. Elec Rev, N. Y.—Sept. 27, 1899. No. 29921.

Specifications.

Notes on Electrical Specifications. Ernest Kilburn Scott. Criticism of the usual form of specifications, discussing the various points in detail. 3500 w. Elec Rev, Lond—Oct. 6, 1899. No. 30222 A.

GAS ENGINEERING

GAS ENGINEERING.

Acetylene.

Acetylene Gas Considered from the Firemen's Standpoint. William McDavitt. From an address at Syracuse, N. Y., convention. Describes the dangerous properties of calcium carbide, and the way to extinguish a fire caused by it. 1400 w. San Plumb—Oct. 2, 1899. No. 30061.

Acetylene Gas Lighting at Hawes. Describes a public scheme of lighting by acetylene gas successfully carried out in a small market town. 700 w. Engr, Lond —Oct. 13, 1899. No. 30310 A.

An Acetylene Gas Plant. Describes a municipal plant at Schönsee, Prussia, designed to supply 2000 burners. 900 w. Eng Rec—Oct. 21, 1899. No. 30289.

Progress in the Acetylene Gas Industry. John B. C. Kershaw. Considers the advance made in the generation and purification of acetylene and the progress in its utilization. 2200 w. Elec Rev, Lond —Oct. 6, 1899. No. 30223 A.

The Chloride of Lime Process for the Purification of Acetylene. F. B. Ahrens, in *Zeitschrift für Angewandte Chemie.* Abstract translation. The objectionable behavior of chloride of lime as a purifying agent and the reasons, and its efficiency. 900 w. Jour Gas Lgt—Sept. 19, 1899. No. 29948 A.

The Papers Read at the Acetylene Congress. Abstract translations of more important papers read, as taken from the report of Herr F. Liebetanz. 2700 w. Jour Gas Lgt—Oct. 17, 1899. Serial. 1st part. No. 30359 A.

Address.

President's Address Before the Waverley Association of Gas Managers. W. B. McLusky. A review of the working details of small gasworks, considering carbonizing, coal temperature and purification, and unaccounted for gas. Also discussion. 5400 w. Jour Gas Lgt—Sept. 19, 1899. No. 29947 A.

Blast-Furnace Gases.

Plants for Utilizing Blast-Furnace Gases. H. Savage. Abstract of a paper in the *Revue Universelle des Mines.* Concerning plants in Belgium and Germany. Also editorial. Ill. 2200 w. Eng & Min Jour—Oct. 7, 1899. No. 30081.

Carbonic Acid.

The Manufacture of Liquefied Carbonic Acid. An account of the London Carbonic Acid Gas Works. Ill. 1300 w. Engng—Oct. 20, 1899. No. 30512 A.

Coke-Oven Gases.

The Utilization of Coke-Oven Gases for Lighting. Abstract from *Stahl und Eisen.* Discusses various methods tried and their results, giving suggestions to obtain the best results. 1800 w. Ir & Coal Trds Rev—Sept. 22, 1899. No. 29961 A.

Utilizing Coke-Oven Gases for Motive Power. A. von Ihering, in *Stahl und Eisen.* A comparison of the relative efficiency of motors actuated by blast-furnace gas and coke-oven gases. 1700 w. Col Guard—Sept. 22, 1899. No. 29974 A.

Gas Liquor.

Treatment of Gas Liquor. Abstracts from "The Mineral Industry" article upon Recovery of Ammonia and Ammonium Sulphate from Gas Liquor, by Hans A. Frasch. 1700 w. Pro Age—Oct. 2, 1899. No. 30006.

Gas Plants.

Dimensions of Gas Plant. Ernest J. Sutcliffe. A tabulated statement of various opinions concerning the size of gas plant in proportion to the work required of it. 1800 w. Jour Gas Lgt—Oct. 17, 1899. No. 30358 A.

The 400-H. P. Gas Producer Plant for the Erie Railroad. Illustrates and describes the main features. 1000 w. R R Gaz—Sept. 29, 1899. No. 29941.

Governors.

All Sorts and Conditions of Governors. E. H. Millard. Read before the North of England Gas Managers' Assn. Considers governors used in gas manufacture. 3800 w. Jour Gas Lgt—Oct. 10, 1899. No. 30247 A.

Illumination.

Another View of Interior Illumination. F. N. Morton. Read at meeting of the Am. Gas Lgt. Assn. Discusses indirect lighting, describing experiments and the success attained. 4200 w. Am Gas Lgt Jour—Oct. 23, 1899. No. 30324.

Mantles.

Influence of Cerium in Incandescent Mantles. W. Bruno. Translated from *Zeitschrift für Beleuchtungswesen.* Gives a report of observations and experiments. 1800 w. Pro Age—Oct. 2, 1899. No. 30007.

The "Cerofirm" Mantle. Résumé of communication by W. Bruno in *Zeitschrift für Beleuchtungswesen.* An account of researeches which led to the manufacture of this mantle. 3200 w. Jour Gas Lgt—Oct. 10, 1899. No. 30-248 A.

Meters.

Notes on Prepayment Meters. A. H. Strecker. Read before the Am. Gas Lgt. Assn. Gives deductions drawn from experience. 2800 w. Am Gas Lgt Jour—Oct. 30, 1899. No. 30507.

Mixtures.

On Gaseous Mixtures. Translation of notes by A. Leduc and by Paul Sacerdote. An examination of the received law. 1800 w. Jour Fr Inst—Oct., 1899. No. 30090 D.

Naphthalene.

The Quantity of Naphthalene in Gas. William Young. On the value as an illuminant of the naphthalene usually present in coal gas. 1700 w. Jour Gas Lgt—Sept. 26, 1899. No. 30077 A.

Pumping.

The Pumping of Gas. George J. Roberts. Read before the Am. Gas Lgt. Assn. Data to aid the engineer in determining the kind and size of pumping plant needed. 1700 w. Am Gas Lgt Jour —Oct. 30, 1899. No. 30508.

Steam Consumption.

The Steam Consumption in a Water Gas Plant. Alten S. Miller. Read at meeting of the Am. Gas Lgt. Assn. Discusses what can be done to cut down the consumption of steam in gas works. 1800 w. Am Gas Lgt Jour—Oct. 23, 1899. No. 30325.

Tar.

A Commentary on Herr G. Liegel's Paper on Preventing the Thickening of Tar, with a Practical Illustration. Frederic Egner. 1700 w. Am Gas Lgt Jour—Oct. 16, 1899. No. 30213.

Water Gas.

Professor Lunge on the Dellwik Water-Gas Process. Abstract translation of an article in the *Journal für Gasbeleuchtung.* Ill. 3300 w. Jour Gas Lgt—Oct. 3, 1899. No. 30155 A.

The Recent Committee on Carburetted Water Gas. J. Carter. Read at Sleaford, Eng., before the Eastern Counties Gas Mngrs'. Assn. On the work of the commission and its object, with the advantages and disadvantages brought out. Discussion. 11500 w. Jour Gas Lgt—Sept. 26, 1899. No. 30078 A.

MARINE AND NAVAL ENGINEERING

Auxiliary Cruisers.

American Liners as Auxiliary Cruisers in the Spanish-American War. W. G. Randle. A report of the service rendered by the St. Louis. 900 w. Marine Rev—Sept. 28, 1899. No. 30022.

Auxiliary Machinery.

Electrical Machinery on Board Ship. Alexander Siemens. Abstract of paper read before the British Assn. Also editorial. Describes prevailing practice. 3300 w. Engr, Lond—Sept. 22, 1899. No. 29980 A.

Electricity for the Auxiliary Machinery on War Ships. Lieut. J. K. Robison. Showing the need of higher economy at the generating end of the plant before electrical auxiliary machinery can attain its full extension on naval vessels. 3500 w. Engineering Magazine—Nov., 1899. No. 30493 B.

Battleship.

H. M. S. London. A recently launched vessel of a new class, of interest because of her armor system. 500 w. Engr, Lond —Sept. 29, 1899. No. 30137 A.

Fishing Boats.

The Maritime Fisheries Exposition at Bergen (L'Exposition des Pêches Maritimes à Bergen). M. J. Pérard. With many illustrations of fishing boats and appliances. 20,000 w. Bull de la Soc d'Encour—Sept., 1899. No. 30457 G.

Flag Ship.

Farragut's Old Flag Ship, the Hartford. Illustrated description of this ship, which is to be preserved as a training ship. 900 w. Marine Rev—Sept. 28, 1899. No. 30029.

Germany.

The Development of German Shipbuilding. The climax of Herr Haack's admirable series of papers, summing up the economic and sociological elements of Germany's wonderful industrial growth, as exemplified to the fullest extent in her ship-building. 4000 w. Engineering Magazine—Nov., 1899. No. 30496 B.

Kearsarge.

Electrical Features of the United States Battleship Kearsage. This is the first battleship to be provided with a complete electrical power transmission plant. Also editorial. Ill. 1500 w. Elec Rev, N. Y.—Sept. 27, 1899. No. 29923.

Life Saving.

Organization and Development of the United States Life-Saving Service. An illustrated account of this work from data furnished by Sumner I. Kimball, chief of the service. 3500 w. Marine Rev—Oct. 12, 1899. No. 30209.

Merchant Marine.

Establishment of an American Merchant Marine. Eugene Tyler Chamberlain. Reviews the progress of maritime nations and their methods, commenting on the active interest among Americans. 2000 w. Marine Rev—Sept. 28, 1899. No. 30025.

Naval Designs.

Notes on Our Recent Naval Program and Designs, with Particular Reference to the Influence of the Spanish War. Philip Hichborn. On the effects of the Spanish war on public opinion, and on expert opinion. 3500 w. Marine Rev—Sept. 28, 1899. No. 30021.

Naval Warfare.

The Naval Warfare of the Future. Lawrence Irwell. Discusses various types of vessels used, the present conditions and the dangers of modern sea-fights. 2500 w. Marine Rev—Oct. 26, 1899. No. 30382.

Oceanic.

Magnificent Decorations and Furnishings of the Oceanic. Interesting views with description. 1500 w. Marine Rev —Oct. 12, 1899. No. 30208.

Windlass and Capstan Gear of R. M. S. "Oceanic." Illustrated description of gear proportioned to work cables of iron 3¼ in. in diameter. 1400 w. Engng—Oct. 6, 1899. No. 30226 A.

Paddle-Wheel.

Early Paddle-Wheel Steamships. Part first illustrates and describes the Hudson River steamers and the steamers of the Fall River Line. 2300 w. Engr, Lond—Oct. 13, 1899. Serial. 1st part. No. 30-311 A.

Practice Ship.

Construction and Equipment of the U. S. Naval Academy Practice Ship Chesapeake. Illustrates and describes this vessel, constructed for the use of the cadets for training. 1600 w. Marine Engng—Oct., 1899. No. 30096 C.

Protective Coatings.

Experiments on the Protection of Steel and Aluminum Exposed to Water. A. H. Sabin. A statement of the results of the continuation of a series of experiments to determine the comparative durability of paints and varnishes. 4200 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30349 E.

Range Finding.

Range Finders and Range Finding. Gives an illustrated description of various range finders, explaining their use, especially on board ships. 4400 w. Ir Age—Oct. 5, 1899. No. 30043.

Revenue Cutters.

New Revenue Cutters. Illustrated description and plans of two vessels of the first class, one for coast service and the other for the Great Lakes. 1500 w. Marine Rev—Sept. 28, 1899. No. 30027.

Searchlights.

Method of Operating Searchlights More Efficiently by Use of Dynamotors. Alton D. Adams. On the changed conditions which render it desirable to operate searchlights independent of the voltage of the system from which the power is drawn, and how it is accomplished. Ill. 1800 w. Marine Engng—Oct., 1899. No. 30095 C.

Shipbuilding Plant.

Electric Power in a Ship Yard. Illustrated description of features of the Chicago Shipbuilding Co.'s plant. 2000 w. Am Elect'n—Oct., 1899. No. 30116.

Shipbuilding.

Marine Engineering and Shipbuildng on the Thames. A brief account of the work now in hand. 4200 w. Engr, Lond—Sept. 29, 1899. No. 30135 A.

Shipbuilding Plant of Wolff & Zwicker, at Portland, Me., on Pacific Coast. Brief illustrated description. 800 w. Marine Engng—Oct., 1899. No. 30-093 C.

Steamship.

The Cunard Liner "Ivernia." Gives the leading particulars of this new vessel, and compares its size with other large steamships. 18000 w. Engng—Sept. 22, 1899. No. 29967 A.

Stern-Wheel.

Stern Wheel River Steamboat for the Klondike Trade. An illustrated description of the "Willie Irving," a vessel plying on the upper Yukon river. 1200 w. Marine Engng—Oct., 1899. No. 30094 C.

Submarine Boat.

The Lake Submarine Boat. Illustrated description of the "Argonaut," invented by Simon Lake, with a statement of the principal facts claimed to be established. 2000 w. Engr, Lond—Oct. 6, 1899. No. 30231 A.

Testing Tools.

Boats and Sails. Walter Burnham. Part first illustrates and describes tools for testing boat models. 3000 w. Sci Am Sup—Oct. 14, 1899. Serial. 1st part. No. 30172.

Torpedo Boats.

American Torpedo Boats of Recent Construction. Waldon Fawcett. Information concerning the excellence of these boats, especially those constructed on the western seaboard. 2000 w. Mod Mach —Oct., 1899. No. 30062.

Our Torpedo Boat Flotilla. Waldon Fawcett. Discusses the policy of the U. S. navy with regard to torpedo boats, and the achievements of the latest boats. 2200 w. Marine Rev—Sept. 28, 1899. No. 30024.

Transportation.

Taking Steamers by Inland Route to the Caspian Sea. Illustrates the method adopted for taking the twin-screw steamer "Meridian" from St. Petersburg through the Marinski Canal system and down the Volga. 700 w. Engr, Lond—Sept. 22, 1899. No. 29979 A.

Transport Service.

Transport Service of the United States Army. Describes the ships and their equipment and comments on the speedy organization. Ill. 2500 w. Marine Rev —Sept. 28, 1899. No. 30030.

Tug Boats.

Type of Fire Tube Boiler Adapted for Tug-Boat Service. Discusses the poor designs of boilers in use in tugboats, and gives illustrated description of a single-ended Scotch boiler to carry 125 lbs. steam pressure. 800 w. Marine Engng—Oct., 1899. No. 30092 C.

Turbine Steamer.

Fast Cross-Channel Steamer. C. H. Parsons. Read before the British Assn., at Dover meeting. Describes a proposed 30-knot turbine boat, stating its advantages. 1200 w. Engng—Sept. 22, 1899. No. 29968 A.

U. S. Coast Survey.

The United States Coast and Geodetic Survey. Herbert C. Graves. A brief review of the history of this work, its systems and importance, with information relating to it. Ill. 3800 w. Marine Rev —Oct. 5, 1899. No. 30080.

Valve Gear.

Long Radial Valve Gear. Lincoln A. Lang. Illustrates and describes a new gear that has been applied to several small steam vessels on the Great Lakes. 2200 w. Marine Rev—Oct. 19, 1899. No. 30298.

Yacht Racing.

Fifty Years of International Yacht Racing. A review of the history of these races, with illustrations and descriptions of yachts. 2500 w. Sci Am—Oct. 7, 1899. Serial. 1st part. No. 30073.

Yachts.

Consideration of the Steam Yacht from the Designer's Point of View. William A. Fairburn. Interesting descriptions of famous yachts, classifying them in five groups. 2700 w. Marine Engng —Oct., 1899. Serial. 1st part. No. 30-091 C.

The Steam Yacht "Josephine." Illustrated description of a beautiful yacht built for P. A. B. Widener, of Philadelphia. 1500 w. Sci Am Sup—Oct. 7, 1899. No. 30074.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Aluminum.

The Possibilities and Uses of Aluminum as Applied to Carriage Building. Percy W. Northey. Read before the Inst. of British Carriage Builders. Presents advantages justifying the use of this metal and the economy in manufacture effected. 1600 w. Automotor Jour—Oct., 1899. No. 30363 A.

Balancing.

Balancing of Motors. H. E. Wimperis. Considers points most important in connection with balancing motors and reducing vibration. 900 w. Automotor Jour—Oct., 1899. Serial. 1st part. No. 30365 A.

Batteries.

The Charging and Care of Automobile Batteries. Theodore D. Bunce, in the *Horseless Age*. An explanation of the general features of the battery, and the care needed. 1800 w. Sci Am Sup—Oct. 14, 1899. No. 30173.

Club.

The Automobile Club of France. Baudry de Saunier. Illustrations of the Club House and history of the society. 2000 w. Auto Mag—Oct., 1899. No. 29933 C.

The Automobile Club of France. Francis P. Mann. History of the organization. 2500 w. Sci Am Sup—Sept. 30, 1899. No. 29930.

Competitions.

The Competition of Heavy Weights, 1898, and the Second Competition of Automobile Cabs, 1899 (Concours des Poids Lourds de 1898, et le Deuxième Concours de Fiacres Automobiles en 1899). M. G. Forestier. A review of the reports and a general discussion of the automobile situation. 9000 w. Mem de la Soc Ing Civ de France—Aug., 1899. No. 30464 G.

Detachable Motor.

A Missing Link Vehicle. Illustrates a detachable motor that may be substituted for the front wheels of any vehicle and so convert it into an automobile. 1600 w. Auto Mag—Oct., 1899. No. 29935 C.

Early History.

The Genesis of the Automobile. John Grand Carteret. Review of progress since the 17th century, giving illustrations. 2000 w. Auto Mag—Oct., 1899. No. 29934 C.

Electric Power.

Electrically Driven Automobiles. (Ueber Elektrisch Betriebene Selbst fahrer). C. P. Feldmann. A review of the electrically driven vehicles shown at the recent Paris competitions. 2500 w. Elektrotech Zeitschr—Oct. 5, 1899. No. 30477 B.

Electric Cabs in Chicago. Illustrates and describes the vehicles of the Illinois Electric Vehicle Transportation Co., giving related information. 2500 w. W Elect'n—Oct. 7, 1899. No. 30112.

Exposition.

The International Motor-Carriage Exposition at Berlin. An account of the opening of this exposition, with illustrated description of some of the vehicles. 2500 w. U. S. Cons Repts, No. 561—Oct. 24, 1899. No. 30336 D.

Gears.

Speed-Changing Gears for Motocycles and Phaetons. Ilustrates and describes several speed-changing mechanisms, showing the necessity for their use with the gasoline motor. 1200 w. Sci Am Sup—Oct. 14, 1899. No. 30171.

Heavy Weights.

Heavy Motor Car Trials in France. Comments on features of interest at the trials held at Versailles. 1600 w. Engr, Lond—Oct. 20, 1899. No. 30514 A.

Henriod System.

The Henriod System of Automobiles. Illustrates and describes the mechanical part of these carriages. 1400 w. Automotor Jour—Sept. 15, 1899. No. 30052 A.

Kerosene Motor.

Secor's Kerosene Burning Motor. Hugh Dolnar. Illustrated description with comments. 1800 w. Am Mach—Oct. 5, 1899. No. 30054.

Some Inaccuracies Corrected. J. D. Lynn. A criticism of statements made by Hugh Dolnar in an article published in the *American Machinist*. 700 w. Am Mfr & Ir Wld—Oct. 19, 1899. No. 30271.

Liquid Fuel.

The Musker Automatic Liquid Fuel Burner. Illustrated description of an apparatus designed for motor vehicles. 1800 w. Automotor Jour—Sept. 15, 1899. No. 30053 A.

Motor Omnibus.

The Siemens & Halske Electric Street-Omnibus (Der Elektrische Strassenbahn-Omnibus der Siemens & Halske A. G.). H. Siebert. Illustrating and describing a vehicle for general street service, using both overhead wire and accumulators, with details of motors and controller. 3000 w. Elektrotech Zeitschr—Sept. 21, 1899. No. 30467 B.

Motor Sprinkler.

An Automobile Street Sweeper and Sprinkler. From *La Nature*. Gives illustrations and particulars of an apparatus which has given very satisfactory results in Paris. 500 w. Sci Am Sup—Oct. 7, 1899. No. 30075.

Motor Vehicles.

Horseless Carriages. George N. Crouse. Brief review of progress in France, England and the United States. 1800 w. Yale Sci M—Oct., 1899. No. 30159 C.

Newport Parade.

Newport in the Lead. Edwin Emerson, Jr. An illustrated description of the vehicles. 2800 w. Auto Mag—Oct., 1899. No. 29932 C.

Plateway.

A Motor Plateway between Liverpool and Manchester. An explanation of Dibbin's scheme, giving a section of road. 1700 w. Automotor Jour—Sept. 15, 1899. No. 30051 A.

Steam Lurry.

The Simpson and Bodman Steam

Lurry. An illustrated detailed description of vehicles of new design, the generator, and tests made. 4000 w. Automotor Jour—Oct., 1899. No. 30364 A.

Steam Wagons.

Recent Experiences with Steam on Common Roads. John J. Thornycroft. Remarks on the importance of building durable vehicles and on tare weight, with brief description of vehicles built to the writer's designs. Ill. 5500 w. Engng—Sept. 22, 1899. No. 29964 A.

Ventilation.

The Removal of Odors from Electric Battery Vehicles (Geruchbeseitigung in Akkumulatorwagen). R. Ulbricht. Describing methods of ventilating the batteries of electrical vehicles so as to prevent unpleasant odors. 800 w. Elektrotech Zeitschr—Sept. 28, 1899. No. 30473 B.

HYDRAULICS.

Hydraulic Machinery.

Some Notes on the Manufacture of Hydraulic Machinery, Gathered in the Shops of the Watson-Stillman Co. Illustrated description. 2000 w. Mach, N. Y.—Oct., 1899. No. 30017.

Niagara.

Power Development at Niagara Falls Other Than That of the Niagara Power Co. W. C. Johnson. Considers early developments, dating back to 1725. 5500 w. Jour Am of Engng Socs—Aug., 1899. No. 29917 C.

Pumping.

See Mining and Metallurgy, Mining.

Snoqualmie Falls.

See Electrical Engineering, Generating Stations.

Turbines.

The Turbines of the Hydraulic Power Plant at Rheinfelden (Die Turbinen der Kraftübertragungswerke Rheinfelden). F. Prásil. With details of construction and description of the regulating apparatus. 2500 w. Schweizerische Bauzeitung—Oct. 7, 1899. No. 30433 B.

MACHINE WORKS AND FOUNDRIES

Ball Bearings.

A Theoretical Study of Ball Bearings (Etude Théorique sur un Roulement à Billes). Prince Gagarine. A mathematical examination of the action of the ball bearings in the Stokes anemometer, but valuable also as a general discussion of the subject. 1500 w. Génie Civil—Oct. 7, 1899. No. 30408 D.

Brass Furnaces.

The Construction of Brass Melting Furnaces. From a paper by E. Millett, read before the Am. Foundrymen's Assn. Illustrated description. 800 w. Am Mach—Oct. 26, 1899. No. 30357.

Car Coating.

Report of Special Committee on Protective Coating for Iron and Steel Cars. Papers by A. P. Dane and J. L. Johnson. Read at convention of Master Car and Locomotive Painters' Assn., at Philadelphia. Report and discussion. 9300 w. R R Car Jour—Oct., 1899. No. 30076.

Castings.

Casting a Cylinder in Dry Sand. R. H. Palmer. Illustrated detailed description. 3000 w. Am Mach—Oct. 26, 1899. No. 30354.

Malleable Castings. Considers early and recent methods employed. 1800 w. Foundry—Oct., 1899. No. 30244.

Manufacture of the Cast Steel Voussoirs for the Alexander III. Bridge, Paris. Describes the foundry methods adopted, illustrating the principal details. 2400 w. Eng News—Oct. 19, 1899. No. 30257.

Competition.

American Competition. E. A. Stevens. Discusses the material, labor and management of American works as compared with English. 2800 w. Engng—Sept. 22, 1899.. Serial. 1st part. No. 29962 A.

Crane Cheeks.

Machining Crane Cheeks. Joseph Horner. Illustrates and describes English practice in crane building. 1500 w. Am Mach—Oct. 5, 1899. No. 30056.

Crane Girders.

The Machining of Crane Girders. Joseph Horner. Illustrations of the machining of cross girders of cranes by the aid of templets. 1200 w. Am Mach—Oct. 26, 1899. No. 30355.

Drill.

Double Radial Drill-Press (Doppelte Auslegerbohrmaschine). A special tool for drilling the field rings of large electric generators. The drills are electrically driven, and full details are shown. 1500 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1899. No. 30428 D.

Dies.

A Compound Punching and Forming Die. W. E. Willis. Illustrated detailed description, with information relating to the working. 1300 w. Am Mach—Oct. 5, 1899. No. 30055.

Fly-Wheels.

Fly-Wheel Designing. C. H. Benjamin. Practical suggestions, with an explanation of the necessary calculations. Ill. 3000 w. Mach, N. Y.—Oct., 1899. No. 30019.

Forgings.

Making Heavy Steel Forgings. Illustrated description of the plant and products of the Bethelehem Steel Co. 3500 w. Mach, N. Y.—Oct., 1899. No. 30015.

Iron Founding.

Modern Iron Founding. C. W. B. Discusses the evils needing attention. Ill. 1800 w. Mech Wld—Sept. 22, 1899. Serial. 1st part. No. 30041 A.

Jacquard.

A New Method of Making Jacquard Cards by Photography (Nouveau Procédé pour la Mise en Carte des Lissus Jacquard au Moyen de la Photographie). A description of the Szczepanik process. The design is photographed through a perforated screen. 2500 w. Génie Civil—Sept. 30, 1899. No. 30405 D.

Joints.

Toggle-Joints. An illustrated explanation of their principles of operation. 1500 w. Mach, N. Y.—Oct., 1899. No. 30018.

Keys.

Standard Keys. Henry Hess. Gives proportions for straight and taper keys, with derivation of the formulas. 1000 w. Mach, N. Y.—Oct., 1899. No. 30016.

Lathe.

Vertical Cross Turret Lathe. Illustrated description of a fine English machine tool. 1700 w. Engr, Lond—Oct. 6, 1899. No. 30233 A.

Machinery.

Defects in Machinery. Editorial on facts given in report of Mr. Longridge to the Engine, Boiler, and Employers' Liability Insurance Co., Limited, concerning the engine and machine details which give most trouble from failure. 1400 w. Engng—Sept. 29, 1899. No. 30125 A.

Machine Works.

A Modern Machine Works (Eine Moderne Maschinen fabrik). A description of the new works of Ludwig Loewe & Co., in Berlin, with many illustrations. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, 1899. No. 30430 D.

Malleable Casting.

Malleable Furnace Practice and Annealing. Notes on the prevailing practice in malleable work. 3800 w. Ir Trd Rev—Sept. 28, 1899. No. 30014.

Molding.

Molding a Bull Ring. R. H. Palmer. Illustrates and describes the work. 2400 w. Am Mach—Sept. 28, 1899. No. 29-926.

Patterns.

A System of Pattern Keeping. G. H. Hall. Describes a system applicable to small shops. 1000 w. Mach. N. Y.—Oct., 1899. No. 30020.

Polishing.

Polishing Machinery (Du Polissage). With many illustrations of general and special devices and an account of their operation. 3500 w. Revue Technique—Sept. 10, 1899. No. 30410 D.

Production.

A Comparison of Hand and Machine Production. Editorial on results of the investigation by the U. S. Dept. of Labor, relating to the relative productive power of hand and machine labor. 1500 w. Eng News—Oct. 5, 1899. No. 30064.

Shells.

Computing the Diameters of Blanks for Cylindrical Shells. George B. Painter. Illustrations and calculations. 1000 w. Am Mach—Sept. 28, 1899. No. 29929.

Shop Practice.

The Revolution in Machine Shop Practice. Henry Roland. Covering the period of the development of the automatic screw machine and tracing the cumulative work of Maudslay, Stone and Spencer in perfecting machine tools for rapid, accurate and economical production. 4000 w. Engineering Magazine—Nov., 1899. No. 30491 B.

Shops.

Maschinenfabrik Oerlikon. Detailed description. 2500 w. Engng—Oct. 20, 1899. No. 30510 A.

Some Considerations Affecting the Location and Design of Machine Shops. Concerning the new shops of the Lane & Bodley Co., of Cincinnati, Ohio. 1500 w. Am Mach—Sept. 28, 1899. No. 29924.

The New Work Shops of Ludw. Loewe & Co., in Berlin. Historical and descriptive account. Ill. 2200 w. Am Mach—Sept. 28, 1899. Serial. 1st part. No. 29925.

The Urbana, O., Shops. Description, with plan, of Cleveland, Cincinnati, Chicago and St. Louis railway repair shops. 1000 w. Loc Engng—Oct., 1899. No. 30002 C.

Standardizing.

Standardizing in Engineering Construction. Sir Benjamin C. Browne. The second paper shows that in specialization lies not only the highest economy and surest industrial success, but the keenest stimulus to the mind and faculties of the workman. 3500 w. Engineering Magazine—Nov., 1899. No. 30490 B.

U. S. Ordnance.

United States Ordnance Factory, from Data Furnished by the Bureau of Ordnance. Illustrated description of the manufacture of big guns. 2000 w. Marine Rev—Sept. 28, 1899. No. 30023.

Works Management.

Works Management for the Maximum of Production. J. Slater Lewis. A thorough study of the problems of so organizing, managing and remunerating labor as to gain the highest efficiency while preserving content and inspiring continued effort among the workers. 3500 w. Engineering Magazine—Nov., 1899. No. 30492 B.

MATERIALS OF CONSTRUCTION.

Coatings.

Coating Cast-Iron Pipes. Thomas H. Wiggin. Describes coal-tar coating. 3000 w. Gas Engs' Mag—Oct. 10, 1899. No. 30346 A.

Elasticity.

The Elastic Equilibrium of a Rectangular Plate (Sur l'Equilibre Elastique d'une Plaque Rectangulaire). Maurice Levy. A mathematical treatment, deducing fundamental equations for various conditions. 1200 w. Comptes Rendus—Oct. 9, 1899. No. 30438 D.

Hose.

Tests of Rubber Hose for Steam Connections on Railway Cars (Prüfung von Gummischläuchen für Dampfheizungs Kupplungen). M. Rudeloff. A valuable report upon tests made for the German State Railway, with full table of results. 3000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part III., 1899. No. 30459 G.

India-Rubber.

The Action of Heat on India-Rubber. Editorial discussion of practical points relating to this subject, about which little is known and much that is misleading has been published. 2500 w. Engng—Oct. 13, 1899. No. 30320 A.

Metals.

The Crystalline Structure of Metals. J. A. Ewing and W. Rosenhain. Abstract of Bakerian Lecture read before the Royal Soc. On the effects of strain and the relation of plasticity to crystalline structure. 2400 w. Engng—Oct. 13, 1899. No. 30321 A.

Microscopy.

Microphotographic Methods (Ueber die Miktophotographie). A. Martens and E. Heyn. A description of the apparatus and methods used in photographing microscopic views of materials at the Government Testing Laboratory at Charlottenburg. 6000 w. 2 plates. Mitt aus den Kgl Tech Versuchsanstalt—Part III., 1899. No. 30458 G.

Screws.

Holding Power of Wood Screws. W. M. Macphail. Read before the Canadian Soc. of Civ. Engs. Gives a record of tests made to determine the relation between the strength developed and the size of the screw when driven in different sized holes in different woods, both parallel to and across the grain. Ill. 1800 w. Engng—Oct. 6, 1899. No. 30227 A.

POWER AND TRANSMISSION.

Compressed Air.

Conveyance of Compressed Air in Pipes. Robert Peele. Concerning the principles governing the losses, and the effects of size of pipes upon transmission losses. 2200 w. Mines & Min—Oct., 1899. No. 30152 C.

Report on Trials Made at Magog, Quebec, to Test the Economy Effected by Reheating Compressed Air. J. T. Nicolson. 1800 w. Compressed Air—Oct., 1899. No. 30118.

See Street and Electric Tramways.

Elevators.

A New Pneumatic Safety Device for High-Speed Passenger Elevators. Illustrates and describes a device designed to combine the immediate action of the clutch device and the gradual action of the air cushion. 1400 w. Eng News—Oct. 19, 1899. No. 30261.

Motive Power.

The Demands of Electro Technics Upon Prime Movers (Anforderungen der Elektrotechnik an die Kraftmaschinen). R. M. Friese. A discussion of the requirements of prime movers for electrical plants, with especial reference to governing. The question of connecting generators in parallel is considered. 7000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, 1899. No. 30429 D.

Pneumatic Despatch.

The Pneumatic Despatch. Gives the leading features, construction and otherwise of a pneumatic despatch constructed under ground in the very heart of London, nearly forty years ago. 1700 w. Engr, Lond—Oct. 13, 1899. No. 30309 A.

Power Generation.

Power Generation—Comparative Cost by the Steam Engine, Water Turbine and Gas Engine. John B. C. Kershaw. Abstract of paper read before Section G of the British Assn. The writer has collected and arranged in comparable form some of the more important data bearing on the cost of power generation. 2500 w. Engr, Lond—Sept. 29, 1899. Serial. 1st part. No. 30138 A.

Speeds.

Stepped Pulleys and Back Gears. Dexter S. Kimball. Describes mechanisms useful in obtaining all speeds in the running of machines. 1800 w. Sib Jour of Engng—Oct., 1899. No. 30341 C.

Wire Tramways.

Wire Tramways. W. R. Shaw. States some of the advantages, the cost of construction, uses, etc., and gives details of tramways now working in various parts of the world. 2200 w. Ind & East Engr

—Sept., 1899. Serial. 1st part. No. 30300 D.

SPECIAL MOTORS.

Gas Engine.

The Westinghouse Gas Engine. Illustrated description of the novel features of a type of gas engine built in sizes up to 1500 H. P. 1600 w. Eng Rec—Oct. 21, 1899. No. 30286.

Gasoline Engines.

The Gasoline Engine in Boats. Herbert L. Towle. A comparison of the engine power in steam and gasoline launches, with discussion of speed, etc. Ill. 1800 w. Am Mach—Oct. 12, 1899. Serial. 1st part. No. 30165.

Kerosene Motor.

See Mechanical Engineering, Automobilism.

Oil Engines.

Judges' Report of the Trial of Oil Engines at the Edinburgh Show, 1899. Gives the conditions of trials made by the Highland and Agricultural Soc. of Scotland, with description and results. 2000 w. Engr, Lond—Oct. 13, 1899. No. 30513 A.

The Oil Engine. Editorial review of the results of the trials at Edinburgh, by the Highland and Agricultural Soc. of Scotland. 1600 w. Engr, Lond—Oct. 20, 1899. No. 30516 A.

See Mining and Metallurgy, Mining.

Petroleum.

Some Disadvantages of Petroleum as a Motive Power. A statement of difficulties met in the use of this fuel as a motive power, and the efficiency obtained. 1700 w. Col Guard—Oct. 13, 1899. No. 30317 A.

STEAM ENGINEERING.

America.

American Engines and Power Plants (Amerikanische Maschinen und Maschinenanlagen). C. Regenbogen. The first of a series of articles based upon a recent tour in the United States. This instalment is devoted to the pumping machinery of the Cambridge waterworks. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1899. No. 30425 D.

Boiler Compounds.

The Use of Boiler Compounds. W. H. Wakeman. Showing that some compounds injure valve seats and disks and cause other troubles. 1100 w. Am Mach—Oct. 26, 1899. No. 30356.

Boiler Inspection.

Inspection of Boilers by Engineers in Charge. W. J. Ranton. On the importance of a personal inspection by the engineer in charge. 1800 w. Power—Oct., 1899. No. 29994.

Boiler Tests.

Comparison of Boiler Tests. Explains facts that will assist in reducing different reports of tests to a common basis. 1300 w. Col Guard—Sept. 29, 1899. No. 30133 A.

The Need of Testing Boilers. Report by a committee of the Engineers' Society of Western Pennsylvania. 1000 w. Eng Rec—Oct. 21, 1899. No. 30288.

Chimneys.

Chimneys. H. H. Kelley. The effect of height and area of the chimney on draft is considered, also form, fuel, etc. 3000 w. Engr, U. S. A.—Oct. 1, 1899. No. 30069.

Circulation.

A Study of the Circulation of Water in Multitubular Boilers (Etude de la Circulation de l'Eau dans les Chaudières Multitubulaires). The beginning of the third section of M. Brillié's elaborate study, devoted to the application of the theoretical principles already deduced. A number of the leading types of water-tube boilers are discussed. Serial, 2000 w. Génie Civil—Sept. 23, 1899. No. 30403 D.

Experiments on the Circulation of Water in Boiler Tubes. M. C. H. Bellens. Experiments made to determine the influence of the diameter of the tubes upon the circulation of water. 1800 w. Power—Oct., 1899. No. 29995.

Condensers.

The Inertia Effect in Condensers (Beharrungsvermögen von Kondensatoren). F. J. Weiss. An exhaustive discussion of the action of central condensers for steam power plants in maintaining a uniform vacuum with variable steam discharges. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1899. No. 30426 D.

Crank-Shafts.

The Stresses in Crank-Shafts. Presents two indicator diagrams and the circumstances under which they were taken, discussing the indications. 1400 w. Elec Rev, Lond—Oct. 13, 1899. No. 30304 A.

Dust Fuel.

The Freitag Apparatus for Coaldust Fuel. L. Kaufmann, in *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrated description of an improved system of automatic stoking with pulverized coal. 1400 w. Coal Guard—Sept. 22, 1899. No. 29972 A.

Explosion.

Boiler Explosion in a Tramway Power House. Describes an explosion apparently due to the gradual deterioration of the plate, at the point of initial fracture from exposure of the joint to the heat of the furnace. Ill. 800 w. Locomotive—Sept., 1899. No. 30153.

Flow.

The Efflux of Gases and Steam under Diminishing Pressure and Volume (Ueber den Ausfluss von Gasen und Dampfen bei Abnehmendem Druck und bei Abnehmendem Volumen). Dr. Weyrauch. A thorough mathematical treatment of the subject of the efflux of gases, as applied to the work of the engineer. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 30, 1899. No. 30427 each D.

Fuel Economy.

The Fuel Economy of Engines in Electric Railway Power Stations. R. C. Carpenter. Read at meeting of the N. Y. Street Ry. Assn. Gives results of 35 tests of electric railway power stations made during the past eight years by trained students of Cornell Univ., under the supervision of the writer. 2800 w. Eng News—Oct. 12, 1899. No. 30179.

Governors.

Experiments Upon the Action of Engine Governors. William George Hibbins. Read at Inst. of Civ. Engs., England. An account of experiments upon nine types of governors, made at Mason College, Birmingham, Eng. Ill. 1500 w. Am Mfr & Ir Wld—Oct. 12, 1899. Serial. 1st part. No. 30167.

Injectors.

Apparatus for Testing Injectors. Charles Francis Park. Illustrates and describes the apparatus which has been designed and placed in the engineering laboratories of the Mass. Inst. of Technology. 3000 w. Tech Q.—Sept., 1899. No. 30345 E.

Reversing Engines.

Reversing Engines for Rolling Mills (Ueber Reversirmaschinen für Walzwerke). L. Ehrhardt. With numerous indicator diagrams, and plans of vertical, three-cylinder, reversing rolling-mill engine. 4000 w. 1 plate. Stahl und Eisen—Sept. 15, 1899. No. 30461 D.

Smoke.

Smoke Abatement. E. A. Brayley Hodgetts. From a paper read at San. Inst. Cong. On the danger to public health and the means of prevention. 4500 w. Br Arch—Sept. 22, 1899. No. 29944 A.

Smoke Prevention. R. H. Hawkins. Remarks on the necessity of getting the combustion as nearly perfect as possible, the importance of careful stoking, and on mechanical stokers. 1200 w. Yale Sci M—Oct., 1899. No. 30160 C.

Valves.

Safety Valves. H. Highet. An examination of various types. Ill. 1600 w. Prac Engr—Oct. 6, 1899. Serial. 1st part. No. 30220 A.

Water-Tubes.

A Novel Boiler-Tube Extractor. Charles J. Mason. A simple device is illustrated for overcoming a troublesome difficulty which often arises in repairing water-tube boilers. 800 w. Mines & Min—Oct., 1899. No. 30143 C.

The Morrin "Climax" Water-Tube Steam Boiler. Description with illustrations. 600 w. Engr, Lond—Sept. 29, 1899. No. 30140 A.

The Niclausse Water-Tube Boiler. Mark Robinson. Read before the British Assn. Refers briefly to the four types of water-tube boilers already in use, and describes new one named. 4200 w. Engr, Lond—Sept. 22, 1899. No. 29981 A.

MISCELLANY.

Aeronautics.

Practical Means for the Conquest of the Atmosphere (Moyens Actuels de la Conquête de l'Atmosphere). Leo Dex. A discussion of the free and captive balloon, including proposed methods of guiding, the aeroplane, the parachute, and the hélicoptère, from the standpoint of the mechanical principles involved. Two articles, 4500 w. Revue Technique—Sept. 25, Oct. 10, 1899. No. 30412, each D.

Copying.

Copying and Duplication Processes for Technical Use (Praktische Erfahrungen über das Copir-und Vervielfältigungsverfahren in der Technik und in den Gewerben). Dr. T. Koller. Giving details of various blue and black print processes for reproducing mechanical drawings, etc. Two articles, 5000 w. Glaser's Annalen—Sept. 15, Oct. 1, 1899. No. 30440 each D.

Humidity.

Reducing Atmospheric Humidity. Frank Richards. A correspondence giving information on this subject. 1700 w. Am Mach—Sept. 28, 1899. No. 29928.

Invention.

Contributions to the History of Inventions at the Commencement of the Nineteenth Century (Beiträge zur Geschichte der Erfindungen am Beginne des Neunzehnten Jahrhunderts). M. Geitel. A general review of the early inventive work in the present century, from the first German patent law of 1815. Two articles, 6000 w. Glaser's Annalen—Sept. 15, Oct. 1, 1899. No. 30439 each D.

Liquid Air.

Liquefied Gases. Robert M. Chamberlin. Reviews briefly what has been accomplished in this field. Ill. 1800 w. Yale Sci M—Oct., 1899. No. 30163 C.

MINING AND METALLURGY

COAL AND COKE.

Accounts.

A Colliery Audit. George Johnson. An outline of an auditor's duty. 1700 w. Col Guard—Oct. 6, 1899. No. 30238 A.

Analysis.

The Analysis of Coal by Roentgen Rays. Radiographs with description of apparatus used. 1500 w. Ir & Coal Trds Rev—Oct. 13, 1899. No. 30335 A.

The Application of Röntgen Rays for the Determination of Ash in Fossil Minerals (Ueber die Anwendbarkeit der Röntgen Strahlen zur Ermittelung des Aschengehalte Fossiler Mineralien). With reproductions of photographs showing the manner in which siliceous matter contained in coal is revealed. 1500 w. 1 plate. Glückauf—Sept. 16, 1899. No. 30453 B.

Brown-Coal.

Brown-Coal Mining in Bohemia. Part first gives the history of the development. 1200 w. Col Guard—Sept. 22, 1899. Serial. 1st part. No. 29969 A.

Carboniferous Rocks.

Life-Zones in the British Carboniferous Rocks. Report of the committee of the British Assn. Reports on carboniferous rocks and fossils from various districts. 2000 w. Col Guard—Oct. 13, 1899. No. 30318 A.

Coal Fields.

An Illinois Coal Field. A. Dinsmore. Particulars in regard to the formation of the country, a history of the development of the mines, and a description of the methods of working them. 3500 w. Mines & Min—Oct., 1899. No. 30144 C.

Grand River Coal Field of Colorado. Arthur Lakes. A description of the geological phenomena found and their effects upon the coal. Ill. 2700 w. Mines & Min—Oct., 1899. No. 30146 C.

The Coalton Coal Field. Andrew Roy. Description of an interesting Kentucky coal field and its development. 600 w. Mines & Min—Oct., 1899. No. 30148 C.

The South-Eastern Coal-Field. Papers by R. Etheridge, and Prof. Boyd-Dawkins, read at Dover meeting of the British Assn. The first dealt with the relation between the Dover and the Franco-Belgian basins; the second discussed the value of this field. Abstracts. 1500 w. Col Guard—Sept. 22, 1899. No. 29971 A.

Coal Plants.

Possible New Coal Plants in Coal. W. S. Gresley. An illustrated description of evidence obtained in studying coal, mostly anthracite. 2000 w. Am Geol—Oct., 1899. No. 30268 D.

Coking.

The Yield of Coal in Coking. Duncan Anderson, Jr. Considers the yield and character of coke as obtained from the beehive oven, retort oven, and platinum crucible respectively. 1400 w. Ir Age—Sept. 28, 1899. No. 29920.

Coke Oven.

The Bauer By-Product Coke Oven. From *Stahl und Eisen*. Illustrated description of a new form of retort coke oven. 1600 w. Am Mfr & Ir Wld—Sept. 28, 1899. No. 29998.

Coke Oven Gases.

See Gas Engineering.

Colliery Guaranty.

The Interpretation of a Colliery Guaranty. Gives the text of a common form of colliery guaranty with the various clauses numbered and explained by references to points which have been decided in the courts. 4400 w. Col Guard—Sept. 29, 1899. No. 30134 A.

India.

The Coal and Iron Making Resources of India. From the report of R. H. Mahon. Deals with coal and coal fields, giving sketch maps of the chief mineral districts. 4200 w. Ir & Coal Trds Rev —Oct. 13, 1899. Serial. 1st part. No. 30334 A.

Machine Mining.

Improvements in Coal-Cutting Machinery. Illustrates and describes a new tunnelling and ending machine especially useful for rapidly opening new mines. 1200 w. Col Guard—Oct. 6, 1899. No. 30235 A.

Machine Mining at Lethbridge, N. W. T. W. D. L. Hardie. Read before the Min. Inst. of Scotland. Describes this coal field and the work and cost of mining with the Sergeant coal-cutting machines. 3500 w. Can Min Rev—Sept. 30, 1899. No. 30033 B.

New Zealand.

Coal Mining in New Zealand. Harrison F. Bulman. Illustrates and describes the property of the Westport Coal Co., Ltd., the method of working, haulage, etc. 3000 w. Col Guard—Sept. 29, 1899. No. 30127 A.

Pay Bills.

A Colliery Pay. George Johnson. Describes the principal sections of labor included, the form of the bill, etc. 3000 w. Col Guard—Sept. 29, 1899. No. 30-129 A.

Records.

Stope Books. Joseph Barrell. A description of the most suitable form of book and illustrations of the manner of recording the variations due to the various methods of working and timbering. 5500 w. Mines & Min—Oct., 1899. No. 30141 C.

Screening Plant.

The New Screening Plant at the Witkowitz Colliery (Dombrau). A. Fillunger, in *Oesterreichische Zeitschrift für Berg-und Huttenwesen.* Illustrated description. 1200 w. Col Guard—Oct. 13, 1899. No. 30315 A.

Spontaneous Combustion.

Method of Ascertaining Whether a Coal May Be Safely Stocked or Shipped. From an article by O. Lang, in *Glückauf.* Extracts and conclusions from a work of Prof. Fischer, of Göttingen. 1500 w. Col Guard—Oct. 13, 1899. No. 30314 A.

Statistics.

The Output, Value and Distribution of Coal During 1898. From the official report of the United Kingdom. 2400 w. Col Guard—Oct. 20, 1899. No. 30520 A.

Testing Plant.

Coaldust Testing Station at the Maria Colliery, Rhenish Prussia. From a communication by Bergassessor Sarter, to *Glückauf.* Descriptive. 1400 w. Col Guard—Sept. 22, 1899. No. 29970 A.

Victoria.

The Coalfields of Victoria. An account of the deposits and recent discoveries. 1300 w. Col Guard—Oct. 6, 1899. No. 30239 A.

Washington Mines.

Coal Mines of Washington. A description of the various mines and an account of their development and prospects. 1600 w. Mines & Min—Oct., 1899. No. 30150 C.

COPPER.

Arizona.

The Copper Queen Mine, Arizona. James Douglas. Condensed from Trans. Am. Inst. of Min. Engs. An account of the mine and its development. Ill. 5000 w. Min & Sci Pr—Oct. 14, 1899. Serial. 1st part. No. 30246.

Idaho.

A New Resource of Copper and Gold. Robert Norman Bell. Letter concerning a new district of rich promise in Eastern Idaho. 2700 w. Mines & Min—Oct., 1899. No. 30147 C.

Roasting Ore.

Roasting Copper Ore at Keswick, Cal. Thomas Neilson. Describes the system of heap roasting, the building of the heap, time required, etc. 2000 w. Eng & Min Jour—Oct. 14, 1899. No. 30217.

Queensland.

Queensland Copper Fields. Information concerning the development and progress. 800 w. Aust Min Stand—Aug. 31, 1899. No. 30157 B.

GOLD AND SILVER.

British Columbia.

Mining in the Boundary District, B. C. Brief description of various mines. Ill. 1200 w. Min & Sci Pr—Sept. 23, 1899. No. 29954.

California.

The Gold Deposits of Nevada County, California. G. P. Grimsley. An account of this district based on a recent visit. Ill. 1000 w. Eng & Min Jour—Oct. 21, 1899. No. 30277.

Chlorination.

The Chlorination of Gold Ores at Mount Morgan, Queensland. Edgar Hall. A description of this plant, which is probably the largest chlorination mill in the world. 1200 w. Eng & Min Jour —Oct. 7, 1899. No. 30082.

Comstock.

The Comstock Lode. L. P. Gratacap. An account of this great deposit and the scheme under way for unwatering the fissure after almost twenty years of idleness. 1500 w. Sci Am Sup—Oct. 28, 1899. No. 30361.

Formation.

The Gold-Bearing Formation of Stephenson County, Illinois. Oscar H. Hershey. A brief discussion of an isolated deposit in appreciable, but not economical quantities. 1200 w. Am Geol—Oct., 1899. No. 30269 D.

Gold Determination.

The Iodometric Determination of Gold. F. A. Gooch and Frederick H. Morley. Gives results of experiments. 1400 w. Am Jour of Sci—Oct., 1899. No. 29936 D.

Gold District.

Buffalo Hump. Don Maguire. Facts about a rich and promising region which has been the scene of great excitement during the past year. 2500 w. Mines & Min—Oct., 1899. No. 30149 C.

Gold-Dredging.

Gold-Dredging in New Zealand. Historical sketch of the dredging industry in Otago, from a paper by W. H. Cutten, with tables showing dimensions and cost, operations and returns. 3700 w. N Z Mines Rec—Sept. 16, 1899. No. 30378 B.

Idaho.

The Twin Springs Placer Company. Idaho. H. L. J. Warren. Illustrated description of the working of these rich deposits. 1700 w. Eng & Min Jour—Sept. 30, 1899. No. 29953.

New Mexico.

Developments in Northern New Mexico. Notes concerning works in the northern part are given in part first. 900 w. Eng & Min Jour—Sept. 30, 1899. Serial. 1st part. No. 29952.

New Zealand.

Quartz-Mining in New Zealand. Report concerning the increase in gold returns from this source. 1700 w. N Z Mines Rec—Aug. 16, 1899. No. 29938 B.

Placers.

Wonderful Dry Placers. A. W. Gifford. Reports that placers of the Jarilla Mountains, New Mexico, yield coarse gold worth $100 a yard. 1200 w. Ores & Met—Oct., 1899. No. 30323.

Siberia.

Lease of Gold-Bearing Land in Siberia. A translation of a circular, issued by the Ministry of Agriculture and Domains, in regard to leasing six tracts of land. 700 w. U. S. Cons Reports, No. 562—Oct. 25, 1899. No. 30337 D.

Slocan District.

A Description of the Bosun Mine. Howard West. Illustrated historical description. 2700 w. B C Min Rec—Aug., 1899. No. 30058 C.

Sulphides.

Concentration of Auriferous Sulphides in California. Considers the value of concentrating machines and the canvas plant. 1400 w. Min & Sci Pr—Sept. 23, 1899. Serial. 1st part. No. 29955.

Utah Mine.

The Daly West Mine, Park City, Utah. H. L. J. Warren. An outline sketch of this lead-silver mine, with illustration and map. 2000 w. Eng & Min Jour—Oct. 14, 1899. No. 30216.

Ymir Mine.

Notes on Ymir Mine and Its Mill Practice. S. S. Fowler. Read before the Can. Min. Inst. Describes the region and its deposits, the progress in mining and the milling practice. 2800 w. Can Min Rev—Sept. 30, 1899. No. 30034 B.

IRON AND STEEL.

Blast Furnace Gases.

See Gas Engineering.

Castings.

See Mechanical Engineering, Foundries.

Charcoal By-Products.

Influence of the By-Products of Charcoal Manufacture on the Charcoal Pig-Iron Industry. H. O. Chute. Shows the dependence of one industry upon another, and the present development of charcoal iron manufacture. 1500 w. Ir Age—Oct. 5, 1899. No. 30042.

Crucible Steel.

Improved Martin Steel or Crucible Steel (Verbesserte Martinstahl oder Tiegelstahl). Otto Thallner. A discussion of the differences between Bessemer, open-hearth, and crucible steel, showing how open-hearth steel may be remelted in the crucible to advantage. Two articles. 6000 w. Stahl und Eisen—Sept. 15, 1899. No. 30462 each D.

Heat Treatment.

Problems of Heat Treatment. Discusses malleable work, chemistry and carbon conversion and the need of perfect combustion. 2500 w. Ir Trd Rev—Oct. 26, 1899. No. 30380.

India.

The Iron Ores of India. Details of the iron ore supplies as given in report of Major Mahon. 4000 w. Ir & Coal Trds Rev—Oct. 20, 1899. No. 30525 A.

Ingots.

Evans' Ingot Stripper. Illustrated description of a machine designed to strip two ingots at the same time, the ingots worked being about 6 ft. high, though both long and short pieces can be stripped with equal ease. 1500 w. Engr, Lond—Oct. 13, 1899. No. 30308 A.

Iron Founding.

See Mechanical Engineering, Foundries.

Open-Hearth.

A New Open-Hearth Steel-Making Process. Alexander Sattmann, in *Stahl und Eisen.* Illustrated description of the process with discussion of the technical points. 3200 w. Ir & Coal Trds Rev—Oct. 20, 1899. No. 30524 A.

Rail Making.

Early Rail-Making in the United States. John Fritz. Extracts from an address at a meeting of the Min. and Met. Section of the Franklin Inst. Brief historical review. 2500 w. R R Gaz—Oct. 20, 1899. No. 30262.

Steel.

Recent Investigations in Steel. H. Sylvester. From the presidential address before the Staffordshire Iron and Steel Inst. Reviews the chief facts that have been ascertained in connection with the hardening of steel and the theories advanced to explain the phenomena. 2000 w. Ir Trd Rev—Oct. 26, 1899. No. 30-381.

MINING.

Accounts.

Mine Accounts. John E. Hardman. Read before the Nelson meeting of the Canadian Min. Inst. Explains a method of cost accounting. 7800 w. Can Min Rev—Sept. 30, 1899. No. 30032 B.

Borings.

The Recovery of the Ropersole Borehole, Kent Coalfields. W. J. Cousins. An illustrated account of overcoming a difficulty arising during deep boring. 1300 w. Ir & Coal Trds Rev—Oct. 13, 1899. No. 30332 A.

China.

Chinese Mining Regulations. A copy of amendments to the regulations governing mines. 900 w. U. S. Cons Reports, No. 553—Oct. 14, 1899. No. 30170 D.

Colorado.

Evolution of Mining and Ore Treatment in Colorado. Thomas Tonge. A comprehensive exposition of the effect of improved appliances, exact methods and economical management in developing low-grade properties and eliminating the element of chance in mining. 3000 w. Engineering Magazine—Nov., 1899. No. 30497 B.

Deep Mines.

Systems for the Raising of Water from Deep Mines. W. M. Epton. Read before the Johannesburg Mech. Engs'. Assn. Enumerates several systems and discusses the loss in getting the power from boilers on the surface to the pump underground. 2500 w. Ir & Coal Trds Rev—Oct. 6, 1899. No. 30224 A.

Deep Pumping.

Deep Pumping at Elliot Colliery, New Tredegar, Monmouthshire. E. M. Hann. Read before the South Wales Inst. of Engs. States existing conditions and gives an illustrated description of the main features of the plant. 2800 w. Col Guard—Sept. 22, 1899. No. 29973 A.

Diamond Drilling.

Practical Notes on Diamond Drilling. H. M. Lane. Illustrated description of the drilling apparatus and how to use it under various conditions. 3500 w. Mines & Min—Oct., 1899. No. 30142 C.

Electric Power.

Electricity as Applied to Mining. J. R. Bainton. Read before the N. S. W. Chamber of Mines. Gives a review of the applications made in the mining industry and the results, with comparison with results obtained by using compressed air. Discussion. Ill. 5000 w. Aust Min Stand—Aug. 31, 1899. No. 30158 B.

Electric Power Plant in the Julius Mine at Brüx (Elektrische Kraftübertragungsanlage auf dem Aerarischen Julius III. Schacht in Brüx). Describing the very complete plant used for pumping, lighting, hauling, and ventilating, in an important mining district in Bohemia. 2000 w. 2 plates. Oesterr f Berg u Hüttenwesen—Sept. 16, 1899. No. 30449 B.

The Plant at the Witkowitz Coal Mine at Dombrau (Die Anlagen der Witkowitzer Steinkohlengruben in Dombrau). A. Fillunger. A fully illustrated account of an important mining plant in Moravia. Three articles. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 23, 30, Oct. 7, 1899. No. 30451 each B.

Winding and Pumping Installations at the Witkowitz Colliery (Dombrau). A. Fillunger, in *Oesterreichische Zeitschrift für Berg und Huttenwesen.* An illustrated description of the electrical power plant. 2400 w. Col Guard—Oct. 20, 1899. No. 30522 A.

Explosives.

Experiments with Liquefied Oxygen as an Explosive (Essai de l'Oxyliquit comme Explosif). An account of experiments recently made in Germany with liquid oxygen as a safety mining explosive. 2000 w. Revue Technique—Oct. 10, 1899. No. 30414 D.

Safety Explosives and Their Ignition. Particulars concerning explosives and igniters taken from report to the Austrian Government. Ill. 2200 w. Col Guard—Oct. 6, 1899. No. 30234 A.

Fans.

A Peculiarity in the Measurement of a Fan's Industrial Yield by Means of a Thin-Edged Wicket. S. Hanappe. Communicated to the Société des Ingénieurs des Mines du Hainaut. Explains how the pressure should be taken and the cause of incorrectness. 2000 w. Col Guard—Oct. 6, 1899. No. 30236 A.

Fan Speed and Pressure Recorders at the Roche-la-Moliere et Firminy Collieries, Loire, France. M. Denogent. Describes the apparatus used, which gives correct indications and requires but little power. 1200 w. Col Guard—Sept. 29, 1899. No. 30130 A.

Haulage.

Automatic Chain and Rope Haulage at the Rheinpreussen Mine at Homberg (Automotorische Ketten und Seilförderung auf der Zeche Rheinpreussen bei Homberg). With plate of details showing the method of driving the cables by the water of the mine, also the manner of connecting the cars. 2500 w. 1 plate. Glückauf—Oct. 1, 1899. No. 30455 B.

Bottom Haulage Landing at the Mammoth Mine. Howard N. Eavenson. Illustrated detailed description of the arrangement and operation. 3000 w. Eng News—Oct. 12, 1899. No. 30180.

Chain and Rope Haulage at the Rhein-Preussen Colliery, Rhenish-Prussia. From a communication by W. M. to *Glückauf.* Illustrated description of an installation for utilizing mine water. 2500 w. Col Guard—Oct. 20, 1899. No. 30521 A.

Hoisting.

The Mähnert Hoisting Apparatus (E. Mähnert's Auftrieb-Förderverfahren). An illustrated description of an improved device for elevating materials by utilizing their buoyancy in a column of water. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 14, 1899. No. 30452 B.

Miner's Lamp.

The Portable Electric Miner's Lamp. Sydney F. Walker. Discusses whether the electric current shall be furnished by a primary or a secondary battery. 2500 w. Col Guard—Sept. 29, 1899. No. 30-132 A.

Mining Law.

The Sale of Coal Under the Weights and Measures Act of 1889. Brief statements of noteworthy adjudications pronounced by the Queen's Beach Divisional Court. 2800 w. Col Guard—Oct. 13, 1899. No. 30316 A.

Mining Machinery.

Care and Maintenance of Mining Machinery. G. D. Rice. Discusses the care necessary for the various kinds of machines, and mentions considerations to be taken into account. 2800 w. Am Gas Lgt Jour—Oct. 16, 1899. No. 30214.

Oil Engines.

Oil Engines as Pump Motors Underground. George L. Kerr. Discusses the various methods of ridding mines of water and gives plan and elevation showing the general arrangement of oil engine and pump for this purpose. 1600 w. Col Guard—Oct. 6, 1899. No. 30237 A.

Pit-Heads.

Pit-Head Pulley Framings. Their Design and Construction. S. A. Everett. Read before the South Wales Inst. of Engs. A survey of the development and discussion of proper construction. 2800 W. Col Guard—Sept. 29, 1899. No. 30-128 A.

Prussia.

Progress in Mining in Prussia During 1898 (Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen während des Jahres 1898). A very complete review of the year's progress, with numerous illustrations. Four articles, 8000 w. Glückauf—Sept. 16, 23, Oct. 1, 7, 1899. No. 30454 each B.

Pumping.

Deep Mine Pumping. W. M. Epton. Abstract of a paper read before the Johannesburg Mech. Engs. Assn. Enumerates several systems, giving the writer's views on each. 2100 w. Am Mfr & Ir Wld.—Oct. 26, 1899. No. 30379.

Electrical Pumping in South Staffordshire, England. W. H. Booth. describes methods used for keeping the water out of the mines. 2300 w. Mines & Min—Oct., 1899. No. 30151 C.

Sampling.

Some Notes on Mine Surface Sampling. S. H. Pearce. Discusses methods and the difficulties met. Ill. 6000 w. Jour Chem & Met Soc of S Africa—Aug., 1899. No. 30299 E.

Small Economies.

The Small Economies in Mining Howard West. Read before the Can. Min. Inst. Relates to conditions in the Slocan district, calling attention to various points neglected. 4500 w. Can Min Rev—Sept. 30, 1899. No. 30035 B.

Ventilation.

Report of the Victorian Mines Ventilation Board. Abstract of report by the board appointed to deal with the applications received for a bonus of £1,000 offered by the Victorian Government for the best method of ventilating mines. 1500 w. Ir & Coal Trds Rev—Oct. 13, 1899. No. 30333 A.

Utilizing for Ventilation the Whole Cross-Section of a Winding Shaft. Bergassessor Dehnke in *Glückauf.* Illustrated description of arrangement to be provided for the Neuenühl Colliery, with its advantages over other described arrangements. 2200 w. Col Guard—Sept. 29, 1899. No. 30131 A.

MISCELLANY.

Diamonds.

Emigrant Diamonds in America. William Herbert Hobbs. A study of the origin of diamonds found in the neighborhood of the Great Lakes. Ill. 3300 w. Ap Pop Sci M—Nov., 1899. No. 30343 D.

Manganese.

Manganese and Related Metals. J. Ohly. Information concerning manganese and its properties is given in part first. 1500 w. Min Rept—Oct. 19, 1899. Serial. 1st part. No. 30338.

Petroleum.

Crude Petroleum and Its Products as Fuel. H. Tweddle. Much information concerning these products and the best methods for burning. 2800 w. Eng & Min Jour—Oct. 14, 1899. Serial. 1st part. No. 30218.

Salt.

The Transformation of the Alpine Salt Works (Ueber die Umgestaltung des Alpinen Salzbergbaues). A. Aigner A review of the improved methods which have been introduced since 1863, and the economy which has resulted. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 16, 1899. No. 30450 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

A Train in the River. Illustrated account of an accident which plunged seven cars and a locomotive into the upper Niagara river. 600 w. Ry Age—Sept. 29, 1899. No. 29999.

Train Accidents in the United States in August. Detailed list and classified summary. 4000 w. R R Gaz—Oct. 20, 1899. No. 30264.

Braking.

Some of the Problems in Train Braking. G. L. Wilkinson. A general discussion of problems relating to the effective working of brakes. 3700 w. R R Gaz—Oct. 13, 1899. No. 30178.

Train Service.

The Winter Train Services. Charles Rous-Marten. Considers the changes on British roads, and a note concerning the "Nord" express of France. 700 w. Engr, Lond—Oct. 6, 1899. No. 30232 A.

Transportation.

The Revolution in Railway Transportation. Editorial discussion of the relation of large locomotives to the problem of cheap transportation of bulk freights, especially considering the new and powerful locomotive of the Illinois Central R. R. 2700 w. Eng News—Oct. 26, 1899. No. 30373.

FINANCIAL

Profits.

British Railway Profits. An editorial review of the traffic returns and working expenditure. 1800 w. Engng—Sept. 22, 1899. No. 29965 A.

Ry. Statistics.

Statistics of Railways in the United States for the year 1898. Extracts from tables given in advanced sheets of "Poor's Manual." 500 w. Eng News—Oct. 15, 1899. No. 30065.

LEGAL.

Rates.

The Kansas City, Pittsburg and Gulf Division. The decision of Judge Thayer, of the Federal Court at St. Louis, ordering the receivers to restore rates to the basis which prevailed before the trouble. 1200 w. Ry Age—Oct. 6, 1899. No. 30111.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Repair and Instruction Rooms of the St. Paul & Duluth Ry. G. R. Parker. Illustrated detailed description of apparatus for repair, testing and instruction purposes. 1400 w. Ry Mas Mech—Oct., 1899. No. 30164.

Handling Freight Trains Partially Equipped with Air. Upon the instructions of C. L. Nichols, Supt. of the C., R. I. and P. R. R., with portion of a recent discussion at the Air Brake Men's Assn. 1500 w. R R Gaz—Oct. 6, 1899. No. 30084.

Car Doors.

Door Fastenings for End-Dump Cars. J. E. Johnson. Illustrated description of the device and its operation. 1500 w. Eng News—Oct. 26, 1899. No. 30370.

Car Lighting.

A New System of Train Lighting. Abstract from the *Revue Géneralé des Chemins de Fer.* Reviews briefly the arrangements of the best known systems and describes in detail one recently applied experimentally by the Paris, Lyons and Mediterranean Co. Ill. 2400 w. Elect'n, Lond—Oct. 13, 1899. No. 30-331 A.

Car Lighting with Pintsch Gas, City Gas and Acetylene Mixture. An explanation of why city gas and mixtures with acetylene are not used in the United States. 700 w. Am Engr & R R Jour—Oct., 1899. No. 30013 C.

Center of Gravity.

Simple Method of Determining the Center of Gravity of Locomotives. G. R. Henderson. Describes method. Ill. 500 w. Am Engr & R R Jour—Oct., 1899. No. 30009 C.

Coupling.

The Progressive Development of the English Coupling. W. D. Phillips. A short sketch showing the stages by which The English coupling has diverged from the American form. 600 w. R R Gaz—Oct. 20, 1899. No. 30266.

Dining Cars.

Model Modern Dining Cars for the Southern Railway. Illustrated description. 400 w. Loc Engng—Nov., 1899. No. 30505 C.

Draft Beams.

Metal Draft Beams. A general discussion, with special description of various designs. Ill. 4200 w. R R Gaz —Oct. 13, 1899. No. 30174.

English Railway.

Notes on the Great Eastern Railway of England. A. M. Bell. Illustrates and describes the equipment, and comments on the excellent feeling between master and men. 1700 w. Loc Engng—Nov., 1899. No. 30506 C.

Hose.

See Mechanical Engineering, Materials.

Intercepting Valve.

Intercepting Valve of the Pittsburg Compound Locomotive. R. Atkinson. Special drawings showing valve in simple and compound positions, with description. 1000 w. Loc Engng—Oct., 1899. No. 30003 C.

Locomotive Boilers.

Heat Transmission in Locomotive Boilers. William Forsyth. Discusses the materials for heating surfaces and the most advantageous lengths of tubes. 2200 w. Am Engr & R R Jour—Oct., 1899. No. 30008 C.

Locomotive Designs.

Two Locomotive Designs. Drawings and description of two designs of advanced practice, one a heavy freight engine, the other a heavy passenger locomotive. 1300 w. R R Gaz—Oct. 27, 1899. No. 30366.

Locomotive Practice.

Locomotive Practice in France and Switzerland. The skill of Swiss engineers in building engines capable of climbing steep grades, etc. Ill. 1000 w. Transport—Oct. 13, 1899. No. 30328 A.

Locomotive Trade.

The Locomotive Trade of Great Britain. Discusses the position of the trade and the reasons for sending orders abroad. 3500 w. Engr, Lond—Oct. 13, 1899. No. 30306 A.

Locomotives.

Australian Consolidation Engine. Illustrated description. 350 w. Loc Engng —Oct., 1899. No. 30005 C.

Express Passenger Locomotive for the Great Central Railway. Illustrated detailed description of engine of the four-coupled inside cylinder type, with a four-wheeled bogie at the leading end. 1600 w. Engng—Sept. 29, 1899. No. 30126 A.

Painting Locomotive Engines. Historical review giving early and modern practice, particularly in England, with discussion of methods and constituents. 3200 w. Engr, Lond—Oct. 6, 1899. No. 30228 A.

Plans for the Systematic Investigation of Locomotives (Ueber die Aufstellung von Plänen für die Regelmässigen Untersuchungen der Lokomotiven). With a number of tables and a graphical scheme for the distribution of inspection throughout the year. 2000 w. Glaser's Annalen—Oct. 1, 1899. No. 30441 D.

Ten-Wheel Freight Locomotives. Illustration and principal dimensions of engines for the Chicago Great Western Ry. 300 w. Am Engr & R R Jour—Oct., 1899. No. 30011 C.

The Largest Locomotive in the World; Illinois Central R. R. Full illustrated detailed description with two-page plate. 1300 w. Eng News—Oct. 26, 1899. No. 30368.

The New Six-Coupled Express Engines for the Northeastern Railway. Charles Rous-Marten. Brief note and photograph of engine already described in issue of July 21. 800 w. Engr, Lond —Sept. 22, 1899. No. 29976 A.

The New York Central Class P Mogul Freight Locomotive. Engravings, general dimensions and interesting data. 900 w. R R Gaz—Sept. 29, 1899. No. 29942.

The 116-Ton Illinois Central Twelve-Wheel Locomotive. Engravings and descriptive specifications with general remarks. 1000 w. R R Gaz—Sept. 29, 1899. No. 29940.

Twelve-Wheel Brooks Locomotive, D. L. & W. Ry. An illustrated detailed description of a powerful freight locomotive, with critical comments. 2500 w. Ry & Engng Rev.—Oct. 14, 1899. No. 30212.

Weight and Efficiency of Locomotives. Ira C. Hubbell. On the efficiency of locomotives as affected by the percentage of weight on drivers to total weight. 1200 w. Ry Age—Oct. 6, 1899. No. 30110.

Ore Cars.

112,000-Pound Steel Ore Cars in Scotland. Illustrated description of cars introduced on the Caledonian Railway. 700 w. Am Engr & R R Jour—Oct., 1899. No. 30010 C.

Signal Lamps.

Maintenance and Inspection of Signal Lamps, A. T. & S. Fé Ry. Information supplied by J. S. Hobson, signal engineer, concerning inspection of lamps in service, repairs, tests, etc. 2200 w. Ry & Engng Rev—Sept. 30, 1899. No. 29997.

NEW PROJECTS.

Africa.

The Railways of Africa. Gives a map showing the principal lines completed, under construction and projected, with particulars. 3500 w. Eng News—Sept. 28, 1899. No. 29959.

China.

Imperial Chinese Railways. J. Grant Birch. A report of recent progress, and related matters. 3500 w. Engng—Oct. 20, 1899. No. 30511 A.

Engadine.

The Engadine-Orient Railway (Der Engadin-Orientbahn). Lieut. Buchholz.

A paper before the German Railway Society upon the proposed railway to connect the eastern cantons of Switzerland with the Tyrol. 3000 w. Glaser's Annalen—Oct. 15, 1899. No. 30442 D.

Hawaii.

A New Railway for Hawaii. Information concerning a road to be known as the Kohala & Hilo Ry., having a trackage of 130 miles. 900 w. Ry Age—Oct. 6, 1899. No. 30109.

India.

The Kalka-Simla Railway. Details and plans of this project for bridging the mountain barrier between Kalka and the hill capital. 2800 w. Ind & East Engr—Sept., 1899. No. 30301 D.

PERMANENT WAY AND FIXTURES.

Ballast.

Handling Ballast on the Michigan Central. Illustrates and describes the method of loading and distributing gravel. 1600 w. R R Gaz—Oct. 13, 1899. No. 30176.

Fuel.

Coke as Locomotive Fuel. Discusses its use on the Boston & Maine R. R. Also editorial. Ill. 300 w. Am Engr & R R Jour—Oct., 1899. No. 30012 C.

Does Increase of Train Speed Entail Increase of Fuel Consumption? Editorial giving evidence that engines hauling very fast trains burn less coal per car mile than those hauling slower trains. 1000 w. Loc Engng—Oct., 1899. No. 30004 C.

Improvements.

Improvements on the Illinois Central near New Orleans. Describes the arrangement of a new yard, and briefly notes other features. 800 w. R R Gaz Sept. 29, 1899. No. 29943.

Prolongation of the Orleans Line to the Quai D'Orsay. From *La Nature.* Illustrated detailed description. 1200 w. Sci Am Sup—Sept. 30, 1899. No. 29931.

Light Railways.

Remarkable Extension of Light Railways in Belgium. Information concerning results attained in less than fourteen years. 2000 w. Engr, Lond—Sept. 22, 1899. No. 29977 A.

Maintenance.

The Organization of the Maintenance of Way Department. E. E. Russell Tratman. Extracts from an address before the first annual convention of the Eastern Maintenance of Way Assn., at Portland, Me. 4500 w. Ry & Engng Rev—Sept. 30, 1899. No. 29996.

Mountain Road.

The Railway from Laqueuille to Mont-Dore (Le Chemin-de-Fer de Laqueuille au Mont-Dore). G. Leugny. With topographical maps, profile, sections of tunnels, and general details of the railway recently completed in Puy-de-Dôme, France. 2500 w. Revue Technique—Sept. 10, 1899. No. 30411 D.

Organization.

The Organization of Railway Engineering and Maintenance of Way Departments. E. E. Russell Tratman. Abstract of paper read at meeting of the Eastern Maintenance of Way Assn., at Portland, Me., somewhat modified. Gives examples now in force on some leading railways. 4200 w. Eng News—Oct. 19, 1899. No. 30259.

Signalling.

Sargent's Automatic Semaphore. Illustrated description of a signal worked by a motor placed in a box at the top of the post. 700 w. R R Gaz—Oct. 13, 1889. No. 30175.

Signalling on the Dover Tramways. Illustrated description of an ingenious system and its method of working. 1100 w. Elec Engr, Lond—Oct. 13, 1899. No. 30303 A.

Signalling Without Contact. W. S. Boult. Read at Dover meeting of the British Assn. Describes a system specially suitable for fog signalling. 4500 w. Elec Rev, Lond—Sept. 22, 1899. Serial. 1st part. No. 30039 A.

Simplon.

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). A general review of the conditions which preceded the undertaking, and an account of the progress up to date. Two articles. 3500 w. Schweizerische Bauzeitung—Oct. 7, 14, 1899. No. 30434 each B.

Speeds.

French and English Railway Speeds. Philip Burtt. Principally an account of what is accomplished in France, and the features which differ from conditions in England. 2200 w. Transport—Oct. 13, 1899. No. 30327 A.

The Fastest Long-Distance Train in the World. Charles Rous-Marten. Information from observation of the Sud Express run from Paris to Spain or Portugal. 2400 w. Engr, Lond—Oct. 20, 1899. No. 30517 A.

Stations.

New York Central Improvements at Albany. Illustrated account of improvements embracing the reconstruction of bridge across the Hudson River, the erection of a new station, and elevation of tracks. 1000 w. Ry Age—Oct. 27, 1899. No. 30509.

The New Pennsylvania Railroad Passenger Terminal at Jersey City. Edward

B. Gumaer. Illustrates and describes the recent improvements. 2800 w. Eng News—Sept. 28, 1899. No. 29960.

The Waverley Station, Edinburgh. An illustrated detailed description of the enlargement, nearly completed, of the North British Railway Company's Waverley station. 4000 w. Engng—Oct. 6, 1899. Serial. 1st part. No. 30225 A.

The Reconstruction of the Railway Stations at Tours (La Transformation des Gares de Tours). MM. Couvrat & Sabouret. A very full account of the improvements recently completed at this important railway center of France. 7500 w. 4 plates. Rev Gen de Chemins de Fer—Sept., 1899. No. 30456 F.

Subway.

See Civil Engineering Construction.

Switch.

Electrically Operated Switches (Weiche mit Elektrischem Betrieb). Dr. Russner. A description of the Jüdel system, by which only a single circuit is necessary for operating the switch in either direction. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 22, 1899. No. 30417 B.

Electrical Switches. William Baxter, Jr. Illustrates and describes various types. 2000 w. Am Mach—Oct. 12, 1899. Serial. 1st part. No. 30166.

Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Continued discussion of paper by W. W. Curtis. 3300 w. Pro Am Soc of Civ Engs—Oct., 1899. No. 30350 E.

Track Tank.

Supplying Water to Moving Trains (Alimentation d'Eau des Locomotives en Marche). An illustrated description, mainly of English and American apparatus for scooping water from a tank between the rails and delivering it to a tender of a moving train. 1200 w. Génie Civil—Sept. 16, 1899. No. 30401 D.

Uganda.

The Uganda Railway (Der Uganda Eisenbahn). Col. Fleck. A very full account of the progress of work, tabulated from the start in 1896 to the present time, with map and profile. 4500 w. Glaser's Annalen—Oct. 15, 1899. No. 30-443 D.

Water Stations.

Pumping Engines for Water Stations. Extracts from a report presented at the Detroit meeting of the Assn. of R. R. Supts. of Bridges and Buildings. 2200 w. R R Gaz—Oct. 27, 1899. No. 30367.

Yukon Ry.

The White Pass and Yukon Ry. A description of the completed portion and its equipments, with maps and illustrations. 1200 w. Eng News—Oct. 5, 1899. No. 30063.

TRAFFIC.

Great Britain.

One of the Busiest Railroads in the World. E. L. Corthell. An account of the Lancashire & Yorkshire Railway. Ill. 2100 w. R R Gaz—Oct. 20, 1899. No. 30263.

Rates.

The K. C., P. & G. Freight-Rate Injunction. Gives facts presented by the Atchison, Topeka & Santa Fé during the recent contest, showing difficulties to be met by new roads in thinly settled country. 1800 w. R R Gaz—Oct. 20, 1899. No. 30265.

STREET AND ELECTRIC TRAMWAYS

Argentina.

Electric Railway Practice in Argentina. E. Manville. An illustrated description and historical account. 5000 w. St Ry Jour—Oct., 1899. No. 30189 D.

Austria-Hungary.

Electric Railway Practice in Argentina. Hungary. E A. Ziffer. A review of the history, with a description of the principal types and methods of construction. 4500 w. St Ry Jour—Oct., 1899. No. 30188 D.

Bombay.

Tramways in Bombay. A short report of the street-car system. 500 w. U. S. Cons Repts, No. 548—Oct. 9, 1899. No. 30086 D.

Car Equipment.

Care of Car Equipment. J. H. Vanderveer. Views of the superintendent of shops, Brooklyn Heights R. R. Co., concerning the proper care. Discussions. Read at convention of the Am. St. Ry. Assn. 9000 w. St Ry Rev—Oct. 19, 1899. No. 30293 C.

Chicago Elevated.

The Elevated Railroads of Chicago. Illustrated detailed description. 8500 w. St Ry Rev—Oct. 15, 1899. No. 30241 C.

Chicago.

The Street Railways of Chicago. Illustrated detailed account. 19500 w. St Ry Rev—Oct. 15, 1899. No. 30240 C.

Compressed Air.

Compressed Air in Traction Service. C. D. Wood, Jr. On the applications to street-railway work especially in New York. 1200 w. Yale Sci M—Oct., 1899. No. 30162 C.

Pneumatic Tramways (Tramways Pneumatiques). An illustrated description of the Popp system of compressed air motors, as used in Paris. 2000 w. Revue Technique—Sept. 10, 1899. No. 30409 D.

Conduits.

Underground Conduit System for London United Tramways. Gives plans with designs for cars and poles to be used on the trolley sections. 1500 w. Tram & Ry Wld—Oct. 5, 1899. No. 30251 A.

Electrolysis.

Electrolysis. A statement of experience in Brooklyn. 700 w. Eng Rec—Oct. 21, 1899. No. 30284.

Freight.

The Right to Do Freight Business on Street Railroads. Gives the substance of Judge Hatch's decision, sustaining the right to carry freight. 600 w. R R Gaz—Oct. 20, 1899. No. 30267.

Fuel Economy.

See Mechanical Engineering, Steam Engineering.

Germany.

Electric Railway Practice in Germany. Louis J. Magee. Illustrates and describes the interesting features of electrical operation in the country named. 7000 w. St Ry Jour—Oct., 1899. No. 30185 D.

The Street Railway System of Hanover, Germany. Woolsey McA. Johnson. Brief illustrated description. 2200 w. Elec Wld & Engr—Oct. 14, 1899. No. 30501.

Great Britain.

Electric Railway Practice in Great Britain. Sidney H. Short. An illustrated review of roads and equipment, especially at Glasgow. 0000 w. St Ry Jour—Oct., 1899. No. 30186 D.

Investments.

Investments in Street Railways. Charles T. Yerkes. Discussion how they can be made secure and remunerative. Discussion. 9000 w. St Ry Rev—Oct. 18, 1899. No. 30295 C.

Laon, France.

Electric Traction at Laon. Illustrated description of a short electric railway with some steep gradients. 700 w. Tram & Ry Wld—Oct. 5, 1899. No. 30252 A.

The Electric Railway from the Laon Station to the City (Le Chemin de Fer Electrique de Laon-Gare à Laon Ville). With views and profile of the tramway from the station to the height upon which the city is situated. 1500 w. L'Electricien—Oct. 7, 1899. No. 30484 B.

Leeds, Eng.

Electric Tramway Extension at Leeds. Illustrates and describes interesting permanent way reconstruction, including considerable bonding, and also overhead electric equipments. 1500 w. Tram & Ry Wld—Oct. 5, 1899. No. 30250 A.

Mileage.

Car Mileage. H. C. Mackay. Read at convention of Am. St. Ry. Assn. The necessity of securing an equitable and standard unit. Discussion. 12500 w. St Ry Rev—Oct. 19, 1899. No. 30294 C.

Motor Control.

The Westinghouse Electro-Pneumatic System of Motor Control and the Baldwin New Trucks for Heavy Electric Cars. Illustrated description of a new system of controlling any number of electric motors from one point; also illustrated description of the new trucks. 3700 w. R R Gaz—Oct. 13, 1899. No. 30177.

Motor Rating.

Notes on Railway Motor Rating. John Lundie. Suggests a rating based upon average output. Also editorial. 900 w. Elec Wld & Engr—Oct. 21, 1899. No. 30273.

Motors.

The Service Performance of Railway Motors. W. B. Potter. A discussion of the horse-power, tractive effort, etc. 1600 w. St Ry Jour—Oct., 1899. No. 30190 D.

Municipal Ownership.

Municipal or Private Ownership and Control. Charles Carroll Brown. Discusses certain phases of the transportation problem. 1800 w. Munic Engng—Oct., 1899. No. 29985 C.

Municipal Transportation.

Electric Railway Practice in America as Exemplified in Chicago. Reviews American experience and explains the latest and best practice, giving an illustrated detailed description of the Chicago construction. 14500 w. St Ry Jour—Oct., 1899. No. 30184 D.

Financial Characteristics of the Large City Transportation Systems of the World. Edward E. Higgins. Tabulated results of investigations of thirty cities are given, with explanations and discussion of different systems and their development. 3500 w. St Ry Jour—Oct., 1899. No. 30187 D.

Rail Bonding.

Rail Bonds. H. P. Brown. A statement of recent experience. 700 w. Eng Rec—Oct. 21, 1899. No. 30283.

Recent Experience in Rail Bonding for Electric Railways. Harold P. Brown.

Condensed from a paper presented at the Toronto meeting of the Am. Soc. of Munic. Imp. Brief reports from various places, and a discussion of methods giving best results. 1000 w. Eng News—Oct. 12, 1899. No. 30182.

Rapid Transit.

The New York Rapid Transit Situation. States the conditions on which contractors for this work are to submit bids. The contract is one of the largest placed since Eads contract for the Mississippi jetties. 1800 w. Eng Rec—Oct. 28, 1899. No. 30388.

The New York Rapid Transit Tunnel. Gives an illustrated description of the construction as planned, the route, stations, equipment, etc. 6000 w. Ir Age—Oct. 19, 1899. No. 30243.

Rouen.

The Electric Tramway Between Rouen and Bonsecours (Le Tramway Electrique de Rouen à Bonsecours). L. Huret. With illustrations of this suburban tramway, and map and profile showing the heavy grades. 1800 w. L'Electricien—Sept. 23, 1899. No. 30483 B.

Small Plant.

A Typical Small Street-Railway Plant. Harry J. Bean. Illustrates and describes the First Street Electric Railroad Company's system, of San Jose, Cal., as an example of most of the electric railway plants in the small cities of the west. 1400 w. Jour of Elec—Sept., 1899. No. 30206.

Toronto, Can.

An Important Canadian Tramway System. Illustrates and describes the tramways of Toronto. 1800 w. Tram & Ry Wld—Oct. 5, 1899. No. 30253 A.

Tracks.

Construction and Maintenance of Street-Railway Tracks. Edward Butts. Read at the convention of the Am. St. Ry. Assn. Presents a construction which experience has shown to be satisfactory. Also discussion. 5000 w. St Ry Rev—Oct. 20, 1899. No. 30339 C.

Recent Street Track at Rochester, N. Y. Illustrated description of rails on longitudinal concrete beams, with crossties of old rails. 500 w. Eng Rec—Oct. 21, 1899. No. 30280.

Traffic.

Heavy Traffic on the Chicago Loop. Report concerning the handling of the heavy traffic on Oct. 9—Chicago Day. 900 w. Eng News—Oct. 19, 1899. No. 30258.

Train Service.

Train Service and Its Practical Application. Ira A. McCormack. Read at convention of Am. St. Ry. Assn. Gives methods which the writer has found useful in cases under his observation. Discussion. 9000 w. St Ry Rev—Oct. 20, 1899. No. 30340 C.

United Kingdom.

The Early Future of Electric Tramways in the United Kingdom. Discusses the outlook and progress expected in the near future. 2000 w. Tram & Ry Wld—Oct. 5, 1899. No. 30254 A.

THE
ENGINEERING MAGAZINE
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JOHN HAYS HAMMOND ON THE SOUTH AFRICAN MINING SITUATION.

THE VIEWS OF THE LEADING AUTHORITY ON THE WITWATERSRAND.

By Charles Buxton Going.

A YEAR ago, writing in this magazine, I used the expression: "Industrial ascendency, not political power, is the animus of modern international struggles. The statesman who directs policies, and the military leader who protects the peace and maintains the order under which alone industry can be established and bear fruit, have thus become servants of the engineer who carries on the actual wealth-making work." The year has ended in the sternest war of the last quarter century—a war springing solely from the struggle of the new spirit of industrial progress against the old forces of political repression. And sooner or later, by force of arms or by sheer moral power, the conflict is certain to end in the emancipation of enterprise and the freedom of engineering effort to develop to the utmost the economic resources of one of the richest mineral regions of the world.

To make clearer than ever the engineering relations of the new order in the Transvaal, Mr. Hammond, whose time did not permit him to write an article, has extended to me the courtesy of an interview explanatory of his annual report to The Consolidated Gold Fields of South Africa, Limited—a report which summarises the situation at the outbreak of the present war. The additional information obtained from Mr. Hammond makes clear the ways in which the industry on the Rand will be bettered by the establishment of good government in the Transvaal.

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Upon this interview this article is based. Mr. Hammond, as is well known, strictly avoids the discussion of the political aspects of the case, though, to quote his own words, "in the Transvaal, economics and politics are so closely connected that it is impossible to tell where one ends and the other begins."

For all statements of a political character, and particularly for the concluding portion of the article, as well as for the wording of the entire paper, the magazine and I are alone responsible.

The Witwatersrand, according to Mr. Hammond's report to the Consolidated Gold Fields of South Africa, Limited, produced in 1898 gold to the value of £15,141,376, being about 25½ per cent. of the total product of the world. If there had been no interruption to mining operations during the year 1899, the output would have exceeded £20,000,000. And it is interesting to note here that this entire output comes almost entirely from a territory lying within a radius of 25 miles from Johannesburg—indeed, 79 per cent. of it is derived from the "central section," stretching from Langlaagte Estate to Knight's, a distance of about 12 miles.

The relation of the Witwatersrand gold product to that of the world is shown in the following summary of the figures for 1898:

Witwatersrand	£15,141,376	25½	per cent.
America	13,419,000	22½	" "
Australia	12,844,200	21½	" "
Russia	5,099,880	8½	" "
Miscellaneous	13,113,544	22	" "
The World	£59,618,000	100	per cent.

The vast yield has been attained by continuous rapid increase since 1887, in which year gold to the value of £80,397 was produced. The entire yield since the inception of mining has been £76,720,000. Dr. Hatch, formerly one of Mr. Hammond's assistants, in THE ENGINEERING MAGAZINE for August last, estimates that within five years the output from the Witwatersrand fields will reach the enormous figure of £36,000,000 per annum.

The present situation of impending change is, therefore, one whose importance is not confined even to the enormous engineering and financial interests directly involved. Anything affecting the production of so large a proportion of the world's stock of gold must exert an influence extending throughout the whole range of economics. But it is the purpose of this supplementary and explanatory comment upon portions of Mr. Hammond's report, obtained in substance from

Mr. Hammond himself, to treat only of the direct bearings of the present war upon the mines and mining conditions, regarded from a purely professional standpoint.

First and foremost: the question presents itself as to the immediate fate of the mines and the vast mechanical installations thus clustered about one of the foci of the Boer activity. Will they suffer destruction, as has been threatened (according to newspaper report)—will they be seized and worked in the interest of the Boer government—or will they merely lie idle and take only the damage due to neglect? Unfortunately, no direct answer seems obtainable. It is not to be believed, however, that any destruction of equipment could receive official sanction. In the first place, contrary to the generally received opinion, the ownership of the mines is vested chiefly on the Continent. British interests are a minority only, the majority of the shares being held in Germany, France, and other European countries. Even should the Geneva Convention exercise but little influence upon the conduct of the Transvaal officials, the large neutral interests involved would deter the heads of the government from directing or sanctioning any wrecking of property or plant. Whether or not the recklessness and lawlessness of the lower elements of the community could be restrained is quite another matter. The Young Boer partisans are hardly likely to weigh very accurately proportionate ownership or the after consequences of wreaking their bitter feelings on the nearest tangible object identified, in their minds, with their enemies. No great confidence can be felt, therefore, that the heads of the government will be able, even if desirous, to protect the mine property from injury. Wholesale destruction is not to be apprehended, but more or less vandalism of a desultory character. For the present, it is likely (as reported) that some of the mines (though only a very few) will be worked for the gold needed by the Boer government, and that such work will be so prosecuted as to yield the largest immediate returns. Only the richest ore is likely to be taken, regardless of good practice or ultimate economy; no attention to maintenance or repairs can be expected; it will, beyond question, be a systematic robbing of the mine and driving of the machinery to death. The removal from the country of most of the competent mining engineers would prevent any general continuance of the industry, but there are enough miners in the Transvaal to carry on, upon a very small scale, such work of this character as is likely to be attempted.

As for the neglected mines, they will not suffer as seriously as would be the case in some other localities or in different formations.

Water is not so troublesome as in many other mining districts, and the mines could be pumped out and operations resumed without inordinate expense. In this regard, the Witwatersrand is much more favourably conditioned than Kimberley, where the character of the mining and of the formation involves grave damage from the filling up of the mines with water.

The mines themselves—the underground workings—are, of course, not much subject to damage. They will remain, and will be reopened and eventually worked under a better order of things than any that has heretofore existed.

While it is to be regretted that the desired economic reforms could not have been attained by peaceful means, there can be no doubt that, having regard to the financial aspect, the drastic measures finally adopted will be ultimately of far greater benefit than the economic reforms which otherwise would have been grudgingly granted. The amelioration of conditions, consequent upon good government, will most materially enhance the value of the properties of the Witwatersrand district. Not only will there be a direct saving per ton of ore treated, but the tonnage of payable ore will be thereby considerably increased.

At present, in the existing mines, there are large quantities of ore of comparatively low grade—say five or six dwts., or about twenty shillings to the ton—which now would not pay to work, even with the reduced working costs which, in recent years, have been attained in spite of scarcity of labour and other disadvantages. What has been done is indicated by the fact that, though the value per ton of ore crushed was 2s. 2d. less in 1898 than it was in 1892, the dividends per ton of ore crushed were 13s. 2d. in 1898, as against 8s. in 1892. Only 19 per cent. of the gold won was distributed in 1892, while 32 per cent. was distributed in 1898.

The sum of 6s. per ton would be a conservative estimate of the direct and indirect benefits of good government. This saving would be equivalent to an enhanced profit per claim of £7,500 to £12,000, and would result in an increase of annual dividends by £2,199,434, based on last year's tonnage of ore crushed. The low-grade ore already referred to in the present mines will be handled through the same shafts, by the same machinery and plant, and to a large extent on the same working expenses already paid by the higher grade. There are also large unopened zones of poorer ore, which may become payable under better conditions. It will, however, take several years fully to realise the saving in question.

The mining economies directly secured by the removal of the present abuses will be in connection with the cheapening of costs of mining supplies, especially of dynamite; with the suppression of the traffic in stolen amalgam and gold; and with the improvement in the labour situation, with which is closely connected the regulation of the traffic in liquor, which, as it has been illicitly carried on, has been a costly item to the mining companies and the cause, as well, of many accidents. The excessive cost of dynamite has been the subject of much discussion and requires no additional comment. It was fully discussed by Dr. Hatch in THE ENGINEERING MAGAZINE last August, and in the same article he reviewed clearly the burden of exorbitant railway charges and their effect in raising the cost of coal and all stores and machinery.* Less prominence, however, has been given to the other points mentioned. The traffic in stolen amalgam and gold is extensively carried on, and its suppression by the co-operation of an honest and competent government would result in a large addition to the revenues of the mining companies. It can exist only through the neglect and indifference of the government officials. Proper regulations, properly put into effect, with a suitable detective force, would make it as impossible to rob the gold-mining companies as it is to rob the diamond mines in Kimberley. Any honest owner can readily account for property of this character, and no other should be able to find a market. In a great majority of instances, the mere possession of such materials is *prima facie* evidence of theft; but so long as the law is lax, the police indifferent and dishonest, and the market free, the companies must suffer.

The labour question has been of the greatest importance in the district. The inadequate supply of native labour has necessitated the undue use of machine drills in mining, resulting in the breaking of a large proportion of barren ground, and in the creation of waste in the ore—which has, in turn, caused a diminution in value. During the continuance of the conditions heretofore existing, no improvement in the labour situation could be expected.

The trouble is not in any lack of suitable material. Black labour is to be had in any quantity, under proper conditions, and the best of it is excellent in quality. The trouble is that conditions have been so bad that none but the lowest element of the blacks would submit to working in the Transvaal, and even these hardly at all except under pressure of absolute necessity. Abuse, extortion, enforced labour on the farms without pay, trickery, robbery of their accumulated earnings by Boers—these have not attracted the negro to the South African Republic. No doubt the regulation of political conditions as between the two races is a difficult one, but the Boer of the Transvaal has not even approached it. Oppression of the blacks has ruined the labour supply of the Witwatersrand, and not the least benefit of a good, honest, and just government will be the amelioration of conditions in this respect. A "hut tax," by which the negro is made to supply some share in the support of the government, and in return for which he receives protection of law, seems to be one of the most successful methods of raising the standing and increasing the responsibility of the native.

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*The Witwatersrand Mines and the Boer Government. By Dr. F. H. Hatch. THE ENGINEERING MAGAZINE, August, 1899, pp. 812-817.

There has been, heretofore, not only lack of good legislation but utter laxity in the enforcement of such law as there is. To this is attributable the deplorable condition as regards the liquor traffic. The statutes are nearly prohibitive, so far as the sale of liquors to natives is concerned, but there is not even a pretence of enforcing them. It is no uncommon sight to see, on a Sunday afternoon, a hundred Kaffirs, miserably intoxicated, with broken heads and eyes nearly knocked out as the result of drunken fights. The liquor is an abominable whiskey of local manufacture, made and supplied often by the very men who preach religion and temperance to the negro.

The peculiarly bad conditions affecting the mining industry are confined to the Transvaal. In the other Dutch republics such flagrant abuses do not exist, and the consequent change in governmental conditions will be correspondingly less. But there will be an indirect benefit at Kimberley from reduced cost of political administration, which will not be without influence.

The temporary suspension of mining activity affords an opportunity to review the tendencies, apparent in mining practice in the Rand, toward the development of the deeper levels. So far, no difficulty has been experienced, either from high temperature or from influx of water, in sinking to depths of 3,700 ft., and Mr. Hammond is still of the opinion that it is possible to work to depths of upwards of 8,000 ft. in the Witwatersrand district. The extent of mining ground embraced within vertical walls of 8,000 ft. cannot now be predicted with any accuracy. In some of the deeper shafts, zones of poorer ore have been encountered, but this is only in conformity with Mr. Hammond's idea of the geology of the banket formation.*

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* The Gold Mines of the Witwatersrand, South Africa. John Hays Hammond. THE ENGINEERING MAGAZINE, Feb., Mar., 1898.

It enforces, however, the idea of carrying out development work as far as possible in advance of milling operations, so as to provide against the contingency of recurring zones of poorer ore.

Certain instances of local steepening of the reefs are only the counterpart of experiences falling to the outcrop companies, and Mr. Hammond still holds strongly to the opinion which he has always maintained—that there is a decided tendency, broadly speaking, for the reefs to flatten in depth. He makes a sharp distinction between a *tendency* to flatten, which is perfectly consistent with all the observations, including the few local exceptions, and a *uniform* or regular flattening, which would be inconsistent with the accepted geological theory. In any case, even the local steepenings are flatter than the outcrop.

The large capital expenditures connected with the mining of the deeper areas require the exploitation of large blocks of claims, and lead Mr. Hammond to recommend the employment of large batteries and shafts, and of mining plant of commensurate capacity. The improved conditions anticipated in the future will more than compensate for the delay in starting operations on the deeper levels.

Captain Mahan, in THE ENGINEERING MAGAZINE for January, 1899, said: "We have two great examples of colonial policy. Great Britain has been, in the main, and increasingly, beneficent and strong. Spain, as the records show, was inhumanly oppressive to the inferior races. But, still more, Spain became weaker and weaker as the years passed, the tyranny of her extortions being partially due to exigencies of her political weakness and to her economical declension. Let us, however, not fail to observe that the beneficence, as well as the strength, of Great Britain has been a matter of growth. * * * Materially, the interest of the nation is one with its beneficence; but, if the ideas get inverted, and the nation sees in its new responsibilities, first of all, markets and profits, with incidental resultant benefit to the natives, it will go wrong. Through such mistakes Great Britain passed. She lost the United States; she suffered bitter anguish in India; but India and Egypt testify to-day to the nobility of her repentance. Spain repented not. The examples are before us. Which shall be followed?"

The remarks, addressed to the United States with reference to the newly acquired dependencies, apply to England to-day. She has not embarked on any war of conquest and aggression, but upon a definite undertaking to right intolerable wrongs, to bring liberty and justice in place of oppression and extortion, and, to quote Mr. Chamberlain, "to do for others what we claimed for ourselves."

Whatever the outcome of the present struggle, her statesmen must not and will not forget their aim, nor be blinded to it by greed of acquisition. The Boers are struggling for independence, as they conceive it. Their fatal mistake has been in seeking independence to do wrong. England's mistake would be equally fatal if she attempted anything but the good of any territory coming under her control.

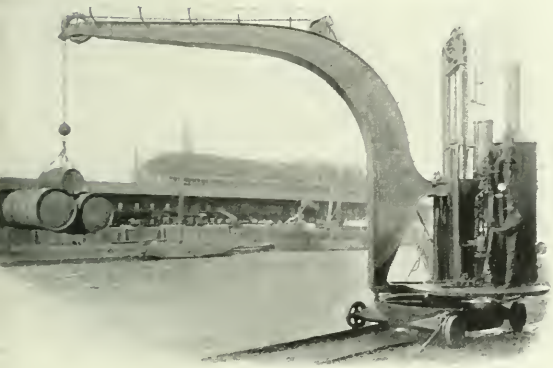
It must be understood that there is nowhere a people more capable of self-government than the better element of the South African white colonists, nor any more determined to secure the ends of freedom, justice, and equality for all the white races. They would be as intolerant of oppression under one national dominion as under another, and sheer force of numbers and moral power would eventually overthrow any tyranny or any influence obstructive to the best governmental ideals and administration. Mr. Hammond declines to discuss the political aspects of the present situation, but competent authorities agree that the future points to an African federation of self-governing states, Imperially connected, probably, with the British throne, but with the largest measure of freedom. Any attempt at coercion from without would be more quickly and more vigorously resented than even the oppression of a domestic oligarchy.

The solution of the present crisis will, no doubt, have a strong, though indirect, influence in that development of the African continent of which Cecil Rhodes is the leading exponent. It is not to be believed for a moment that he—or any association of men—has directly influenced the precipitation of the present struggle, nor that it would have been possible for him to do so had he been disposed. It is part of an organic progress toward fuller life, in a region destined to play a large part in the world's economic future. Mr. Rhodes is keen to discern the march of events, and to place himself in the lead in ordering and directing them. The Boer government has been in the hopeless attitude of striving to stay them.

It is obvious that the whole world is vitally concerned in the wise and permanent adjustment of the South African problem. It is an economic question, in which the engineer's insight is clearest and his influence strongest. Every man in the profession should array himself on the side of sound and enlightened policy, to the end that the English Government may not only make such a policy the basis of its dealings with future Africa, but may clearly and promptly declare the justice, honour, and liberality of its purpose, and so enlist the moral adherence of the civilized globe. Industry rules the world, and industry is founded on freedom.

MECHANICAL TRANSPORT APPLIANCES IN ENGINEERING WORK.

By A. J. S. B. Little.



IN the preceding issue of this Magazine I pointed out the too general apathy of engineers—especially in manufacturing works—to the vast advantages to be gained by the intelligent use of transport appliances, and I endeavored to show, by specific examples, the labour-saving and cost-saving value of conveying machinery.

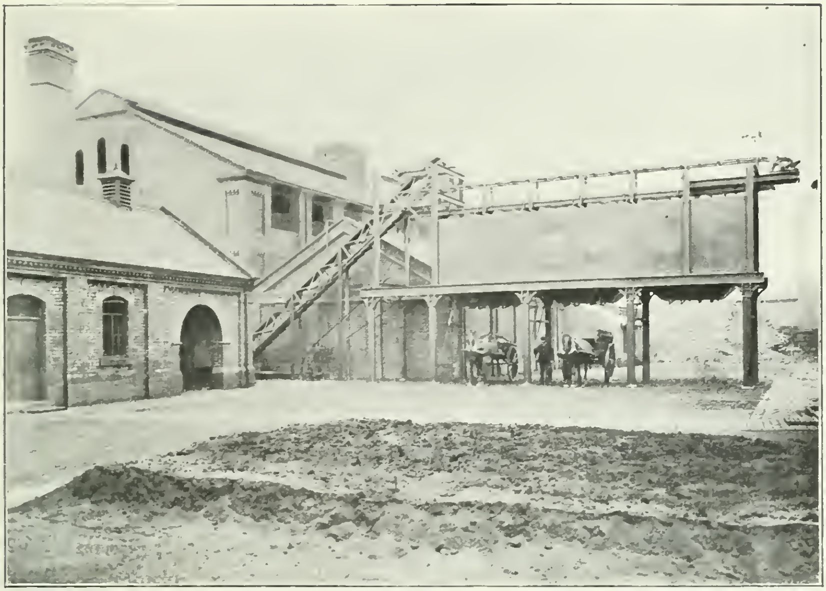
There is not space at disposal to give even a summary of the industries in which the transport-machinery specialist, by the successful introduction of automatic distributing machinery, has altered the method and reduced the cost of working; suffice it to say that wherever matter has to be shifted mechanical appliances are applicable and the question left for consideration is: "Will such a plant pay?" In presenting details of a few installations, therefore, due consideration has been given to selecting those most likely to interest a large class of engineers, and the figures given will probably guide those contemplating extensions or alterations on similar lines. It is well to remember, however, that the more successful a new system turns out, the greater becomes the difficulty in getting figures from the users.

In handling coal to boilers, the fundamental principle to observe is expedition. This, combined with a well-located store of ample capacity, filled automatically, results in a good labour economy.

A boiler house situated on the Tyne, having nine boilers fitted with automatic stokers, is supplied with coal through travelling hoppers, suspended from overhead coal bunkers filled with fuel from a push-plate or drag conveyor placed longitudinally above them and fed from an elevator situated on the wharf. The coal is "grabbed" out of the barge, raised by a steam-driven crane, and dumped into a weigh hopper of 3-tons capacity. The crane man has under observation the spring balance attached to the end of the beam and after registering a charge he can discharge the coal from the weigh hopper to a fixed coal pocket on the elevator boot. Thus the elevator has a load on sufficient to last till the next weigh has been made. The elevator has a double strand of chains (each having working strain of 1,500 lbs.) which carry the 24-in. wide buckets, pitched 2 ft. apart, the whole being capable of lifting 40 tons an hour. The conveyor is of scraper design, with lattice framework and noiseless wood guide paths. The pioneer users of this style of conveyor were greatly troubled by the noise which was produced when working. Still this conveyor might appropriately be called a "howling success," and certainly it proved the forerunner of conveyors which are now made with every wearing part renewable and all parts in sliding contact lined with hard wood. The shoots serving the stoker hoppers with coal are made to swivel as well as travel; thus full advantage can be taken of each hopper which, by means of the oscillating movement thus obtained, is perfectly filled.

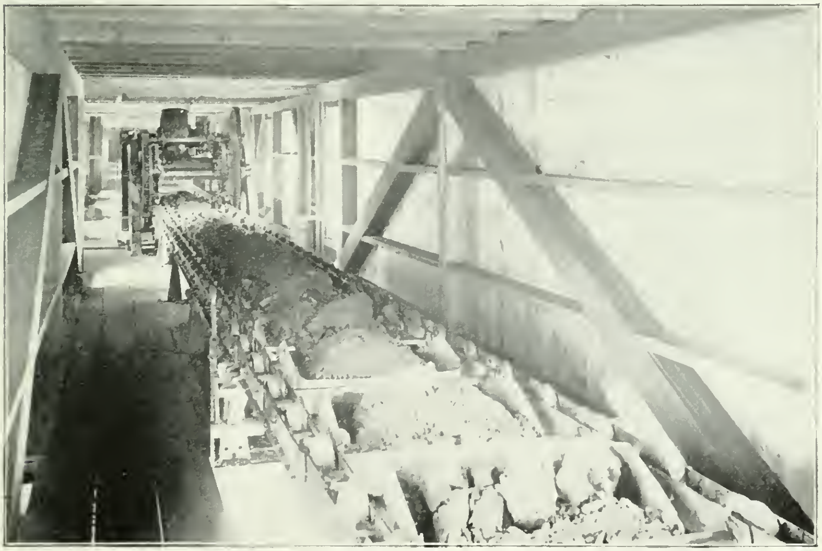
COKE CONVEYOR, NEW ENGLAND GAS AND COKE COMPANY'S WORKS, EVERETT, MASS.
Length, 200 ft.; angle, 21°; width of belt, 24 in.; speed, 500 ft. per minute; capacity, 200 tons per hour. For use as a picking or sorting belt, these conveyors are designed with two flat pulleys instead of one. Robins Conveying Belt Co.

A request for figures of working cost was met by a refusal, supplemented by the explanation that it was against the rules of the firm to



CHAIN-DRIVEN COKE CONVEYOR, LEIGH GAS WORKS, LANCASHIRE.

The same style of plant is used for ash, quartz, bones, etc. The New Conveyor Co., Ltd.

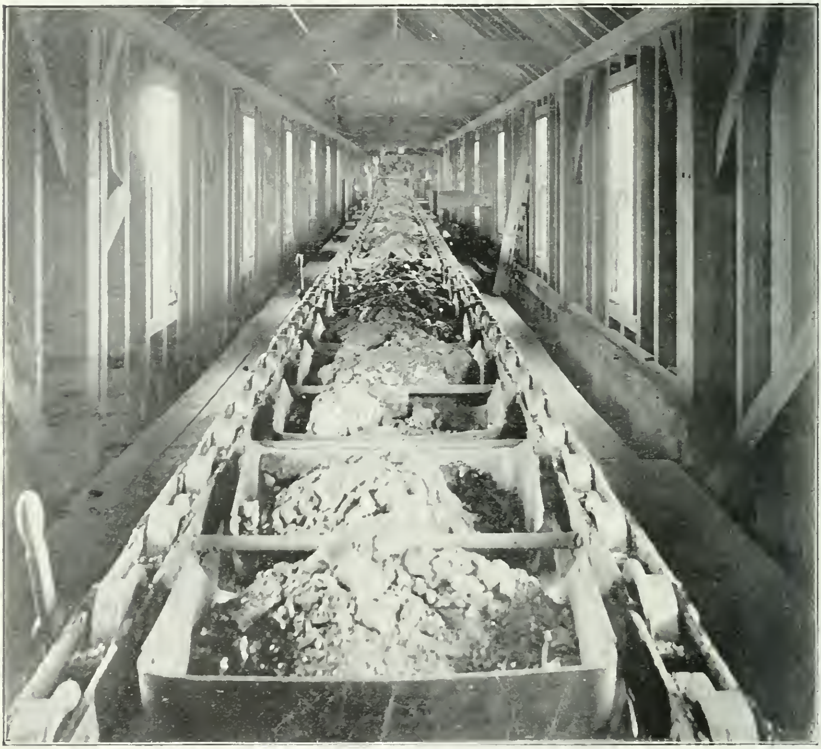


COAL CONVEYOR FOR THE BOSTON & ALBANY R.R., AT ALSTON.

The C. W. Hunt Co.

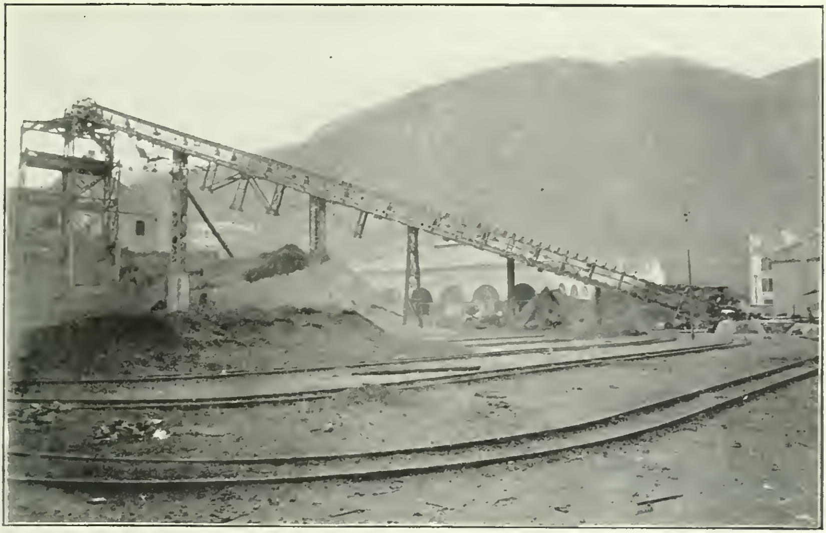
supply any information respecting plant adopted by them; but it may be interesting to know that the cost of this coal-handling plant, erected complete, was about £730. The man who looks after the machinery, in his spare time drives a car or acts as conductor, cleans lamps and mends drains—in fact, does all the odd jobs on the works.

In handling coke it is essential that the form of transporting appliance adopted should have few wearing parts, that all of these be kept as free from grit as possible, and that they be get-at-able and simple, to facilitate and cheapen renewals. The latest conveyor which is illustrated in this article is for handling hot coke received direct from retorts. It will be noticed that the bottom of the trough has a raised part running the whole length and forming, at each side, small gutters, into which the coke dust falls and along which it is conveyed by means of pushplates or scrapers to the breeze or dust-collecting box



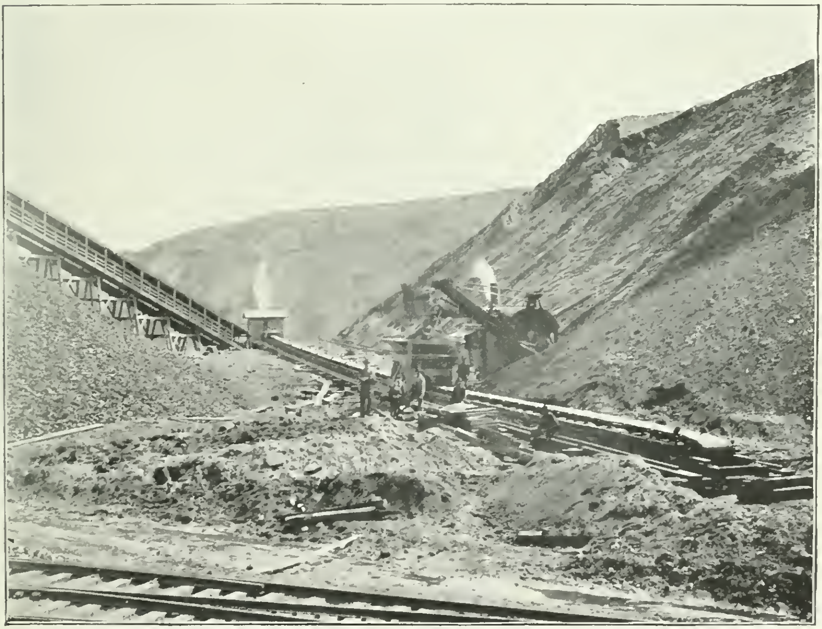
COAL CONVEYOR OF THE BOSTON & ALBANY R.R., AT BOSTON.

The cut shows the long run of the conveyor, which is of the noiseless type, the buckets being carried by wheels at the sides. The C. W. Hunt Co.



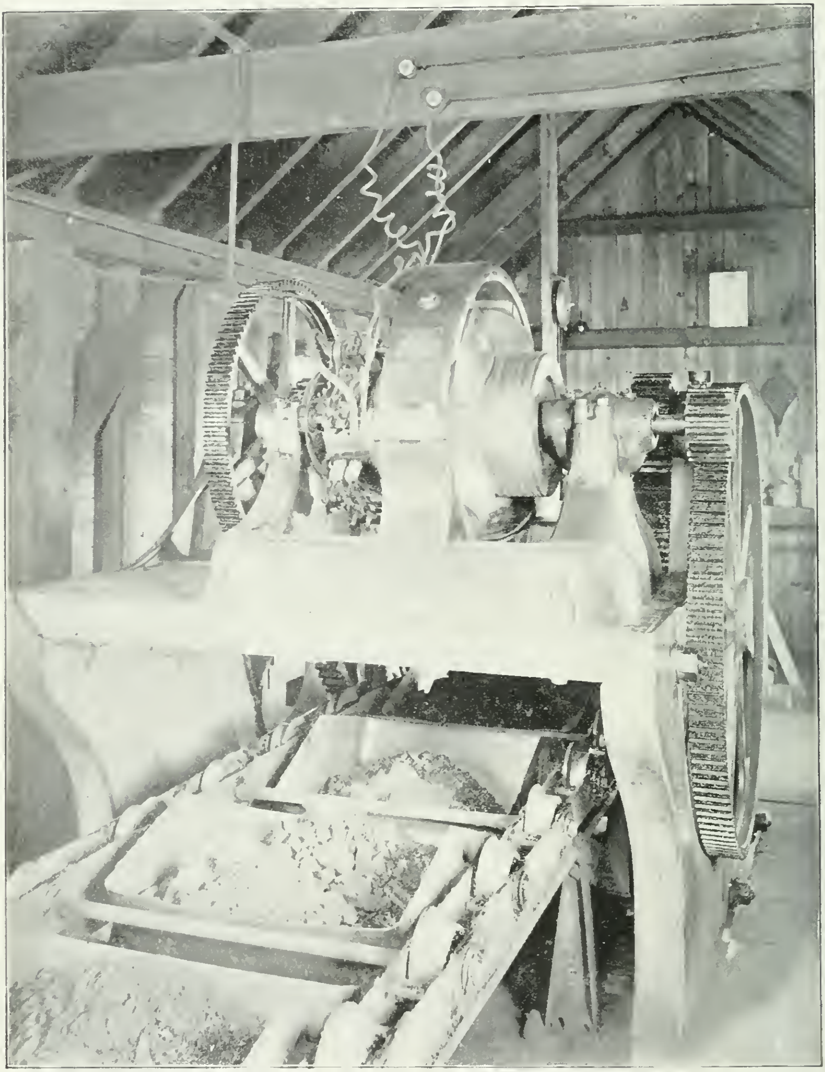
AN INCLINED COAL CONVEYOR IN CHINA.

Carries coal to storage heap, discharging through any portion of bottom trough.
Blake, Barclay & Co.



BELT CONVEYOR AT A CULM WASHERY, PENNSYLVANIA COAL CO., PITTSTON, PA.

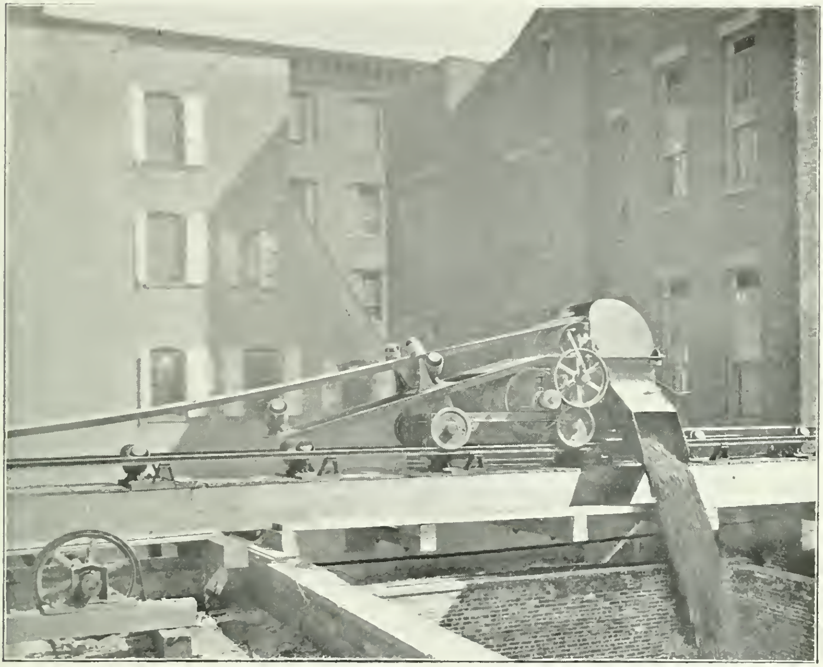
The culm is fed to the conveyor by a movable hopper, thus insuring even delivery to the belt and to the screens in the washery. After each full cut by the steam-shovel the movable conveyor is shifted bodily, sideways, close to the bank again. Length of conveyors, 250 ft. each; width of belt, 24 in.; speed, 600 ft. per minute; capacity, 250 tons per hour. Robins Conveying Belt Co.



DRIVING MECHANISM OF A NOISELESS COAL CONVEYOR.

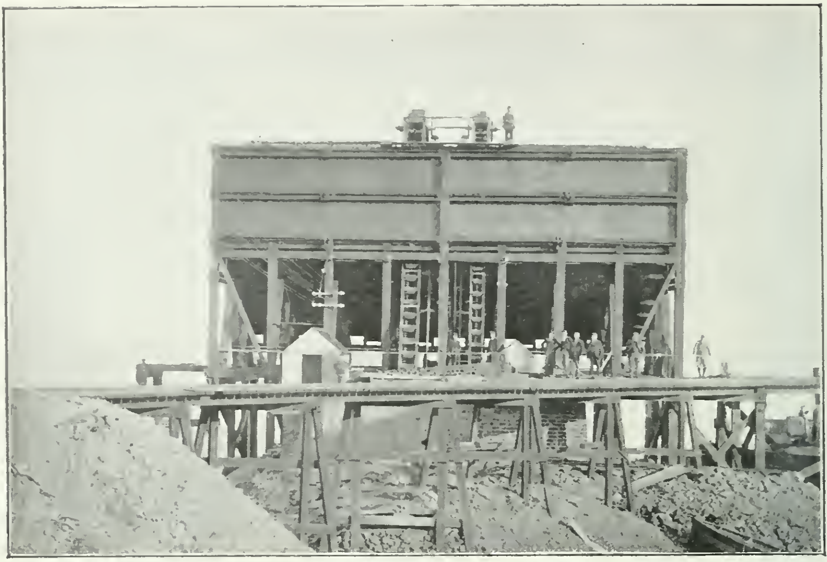
The plant is that of the Boston & Albany Railroad, at Boston and is electric driven.
The C. W. Hunt Co.

fixed at the delivery end. The part of the trough on which the endless chain slides is lined with Australian "iron-wood" in double strips, the top strip secured to the under one in a way which admits of easy and cheap renewal. The chain is formed of alternate ordinary oblong links and flat-steel-section bar links, each of the oblong links being made from a bar of round steel bent to fit the openings in the flat-bar links. After the round links are threaded through the openings of the flat links, the openings in the latter are closed over by a cover plate; and on the top of this cover plate there is fixed to each flat link another plate of the proper width to work in the trough. These coke-carrying plates are about an inch longer than two links, so that a neat joggle is formed to overlap each plate, which presents a nearly level steel-belt surface on which the hot coke is conveyed at about 30 ft. per minute. The dust, formerly so detrimental to chains unprotected from coke grit, falls into the gutters, whence it is removed by the push-plates, fixed at intervals of 4 to 10 ft., to the underside of the plates, so that as the machine is at work conveying and slaking the coke along the trough, the push-plates or scrapers also shovel the coke dust along the gutters, and deliver it out at the end of the trough. The endless chain



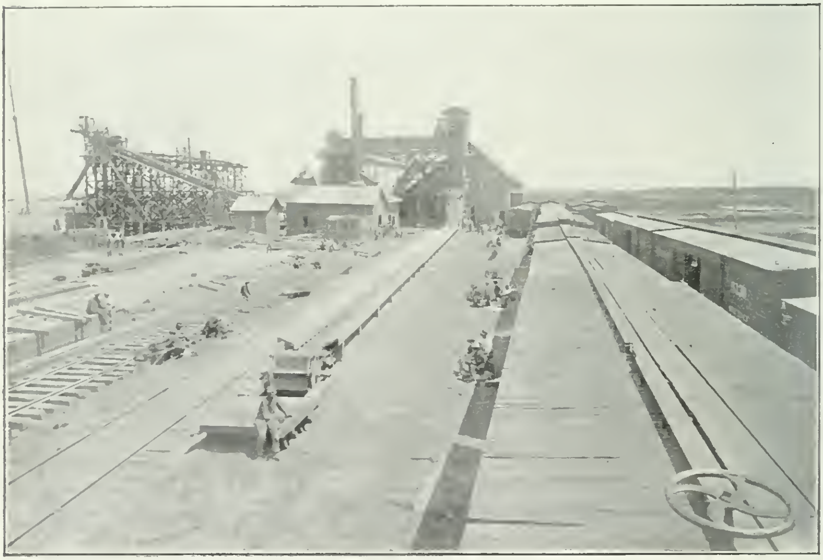
BELT CONVEYOR WITH SELF-MOVING TRIPPER FOR INTERMEDIATE DISCHARGE.

The tripper is moved forwards or backwards by gearing the driving wheels with one or other of the large pulleys over which the belt passes, and which have opposite directions of rotation. Reversal can be made automatic. Length of conveyor, 100 ft. at 18° and 60 ft. level, width of belt, 18 in.; speed, 500 ft. per minute; capacity, 80 tons coal per hour. Robins Conveying Belt Co.



SCREENING, BREAKING, ELEVATING, CONVEYING, AND STORING PLANT FOR LIMESTONE HANDLING.

North Lonsdale Iron & Steel Company's Works, Ulverston, Lancashire. 15x20 in. push-plate conveyors and elevators to large hoppers. Enables boats to come in, load, and depart on one tide. New Conveyor Co., Ltd.



OPEN-TOP CARRIER FOR CONVEYING PHOSPHATE ROCK.

The plant is that of the Florida Central & Peninsular R.R., Fernandina, Fla. It carries from cars to storage buildings, or thence to vessels, or direct from cars to vessels. Capacity, 200 tons per hour. Overlapping buckets 18x36 in. are carried on self-oiling rollers. Stock cannot fall between them. Link Belt Engineering Co.

travels on the wood paths all along the trough, and round the driving or end drums in the usual way, and back over the rollers carried by hangers under the trough, these being securely braced.

This conveyor discharges into a large hopper over elevator, the coke being fed with surprising regularity by means of a side-jigging feeding shoot which effectually prevents choking, even with large pieces of coke passing through the buckets. It is not unusual to see 10 tons of rough coke stacked over the elevator boot and the whole plant worked by one man. The elevator, which is usually about 50 ft. centres, discharges onto a plate carrying conveyor, from 2 to 6 ft. wide, carried over the coke-storage yard; at one point on the line of the conveyors the coke is discharged over a screen and graded into hoppers under which carts, trucks, barges, or bags are placed. The operation of filling these is performed by pulling a lever from the ground level, takes no appreciable labour, and consumes less than a minute.

DRIVING END OF A 275-FT. CONVEYOR, 30-IN. WIDTH.
The conveyor has triangular ploughs, and deposits material at any point desired.
The New Conveyor Co., Ltd.

In a gas works where, say, 60 tons of coke have to be removed in the 24 hours, the complete system could be started up for £2,000—or,

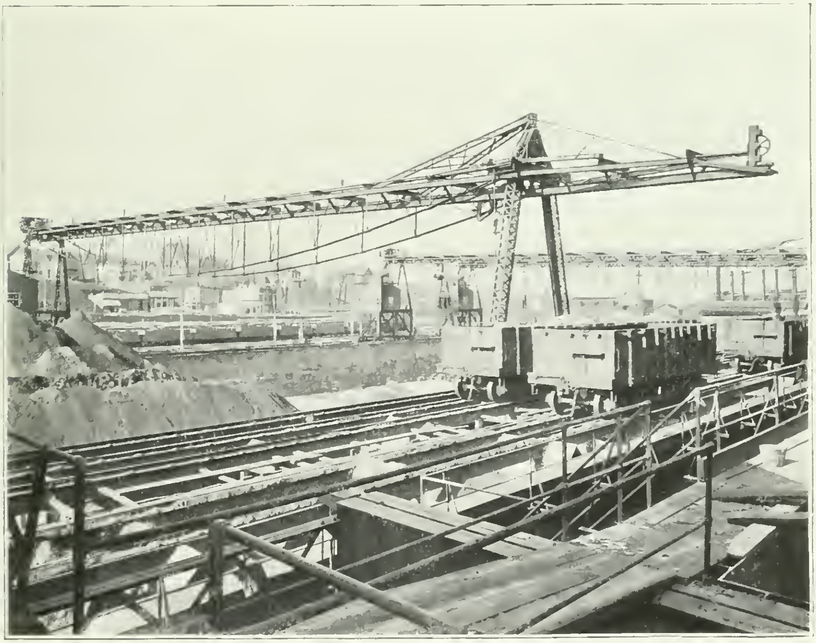
MECHANICAL ORE-HANDLER AT A RUSSIAN IRON WORKS.
The plant is at Mariopol, at the furnaces of the Société de la Providence. Installed by Brown Hoisting & Conveying Machine Co.

say, half this sum if only the outside screening and stacking arrangement were adopted; in this case barrows or tipping trucks would be requisite to bring the coke from the retorts to the elevator hopper. The complete installation, after taking all repairs into account, effects a saving of at least 1s. per ton; from figures given me by Mr. Hack, of Saltley Gas Works, Birmingham, I find that the outside plant shows a saving of 7½d. per ton, after deducting cost of all repairs; further, Mr. Hack states he would strongly advocate the introduction of similar machinery even if there were no saving, as it so greatly lightens the men's work and reduces the number of labourers, which is important in the winter time when great difficulty is experienced in finding sufficient men to do the work.

The illustration of the coke plant at Leigh was taken 7 years ago and the conveyors are still working daily. It is hardly necessary to describe how ashes can be similarly conveyed, pocketed, and shot into carts, at a reduced cost, as arrangements can be seen in operation in most districts. A good ash plant costs about £300, and the saving in labour and other costs varies considerably with local conditions.

At a steel works in the Midlands a new idea has been put into execution, whereby the slag is made into a marketable product. Trucks from the converters are emptied into a pan mill, and the triturated slag is dropped onto two cotton-band conveyors, 12 in. wide x 40 ft. long. which discharge into elevators having 12-in. wide buckets to lift the powder to a height from whence it is conducted through funnels to the weighing machines, where it is bagged and trucked. The small pieces of slag from mill gravitate to two 12-in. wide steel-belt conveyors, 60 feet long, which are relieved of material by other 12-in. elevators having discharge into tiger mills situated over weigh machines; these mills work simultaneously with those handling the powdered slag from the pan mill. The wear-and-tear is greater than in a coal-handling plant, but it is not excessive, no renewals having been required during the three years the plant has been at work. There is no limit to the magnitude or capacity of automatic conveying and elevating machinery. A plant in Hongkong takes coal from boats through a culvert under three streets, a distance of two miles, to storage ground where smaller elevators and conveyors distribute it at rate of 50 tons an hour.

In steel works, the gas producers are charged automatically as fol-



ORE-STORAGE AND REHANDLING PLANT.

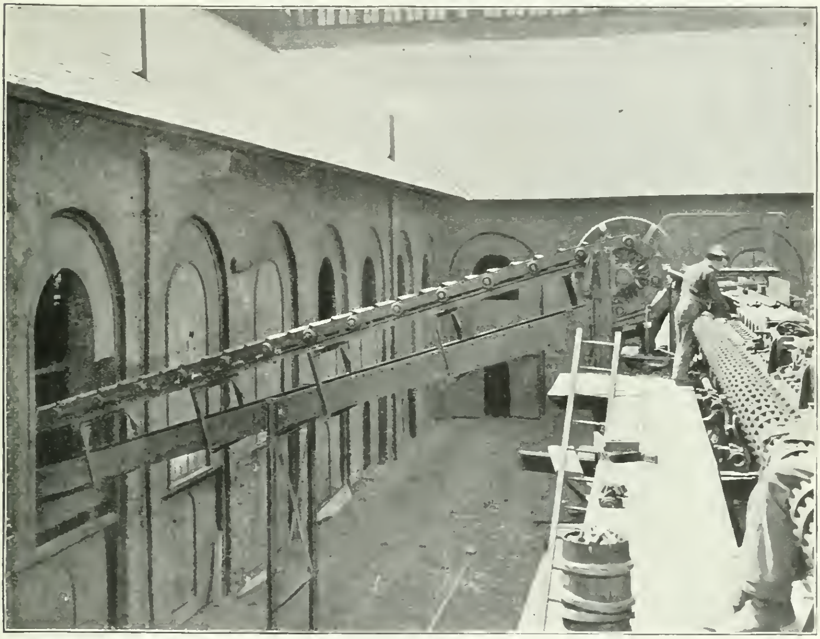
Erected at the Duquesne furnaces of the Carnegie Steel Co., and now being duplicated for the Dominion Iron and Steel Co., Cape Breton. By the Brown Hoisting & Conveying Machine Co.

lows: With seventy-eight producers laid out in three rows, each row has erected over it a lattice-braced structure, carrying a measuring box placed over every "bell mouth" in such a manner that "tickling" of coal is not interfered with; the chambers hold about 10 cwt. and are filled by conveyors and elevators, the arrangement being quite automatic and laid out as follows: Trucks of small coal are shunted to a coal road and passed over hydraulic rams, which kick-up one end and shoot the coal into large hoppers, underneath which is a slow-running plate conveyor 3 ft. 6 in. wide, which regulates the feed to an elevator having buckets 36 in. wide. This lifter is located centrally to producers and is 60 ft. high; it dumps into a cross conveyor of push-plate design. The elevator boot is 17 ft. below rail level, and has fixed between it and the feeder belt a screen, which is used when small coal is scarce and "tripping" or unscreened coal has to be used. The coal, passing over this, is fed to a crusher and the small coal falling through the jigger goes direct to the elevator. The conveyor at the elevator head, 32 ft. above rail level, is of push-plate design, 24 in. wide and 66 ft. long, made with three outlets to feed the conveyors fixed in line with each row of producers, to take the coal to right and left of elevator. These conveyors vary from 160 to 360 ft. in length and are 15 in. wide, of

SPECIAL GANTRY CRANE FOR MOVING STEEL RAILS.
Installed at Pennsylvania Steel Company's works, Steelton, Pa. Span, 200 ft.
Brown Hoisting & Conveying Machine Co.

scraper design, and made to drop the coal at will to any of the 10-cwt. measuring chambers. The total length of the five is 1,400 ft. and they will convey 50 tons per hour, requiring 52 b. h. p. to drive them. The power is produced by six electric motors of the enclosed type. To put up a similar sized installation would cost from £5,500 to £6,000, including everything except producers. Wear would not be noticeable, and might be put down at £20 a year.

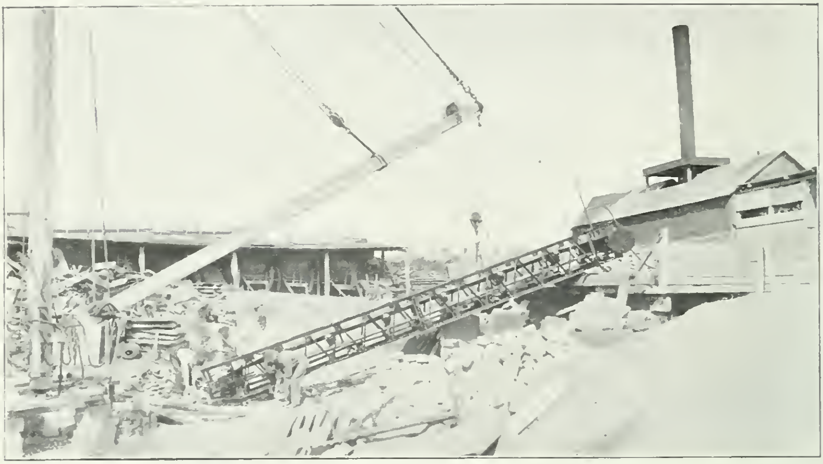
Wire ropeways on any of six systems described below are most serviceable, doing excellent work with a reasonable outlay at a comparatively low working expense. The different styles are:



STEEL-BILLET CONVEYOR AT BETHLEHEM IRON CO.'S WORKS, SOUTH BETHLEHEM, PA.
The conveyor, 90 ft. centers, receives billets after passing through shears, and delivers them to live rolls. Link Belt Engineering Co.

(1.) Endless running rope with carriers hanging therefrom and moving with it through frictional contact; this form is applicable where the quantity of material to be carried does not exceed 500 tons per 10 hours, where the conveyor is to work horizontally or at an angle not exceeding 1 in 3, where the individual loads are less than 6 cwt., and where the section of ground does not call for spans of greater length than 600 ft.

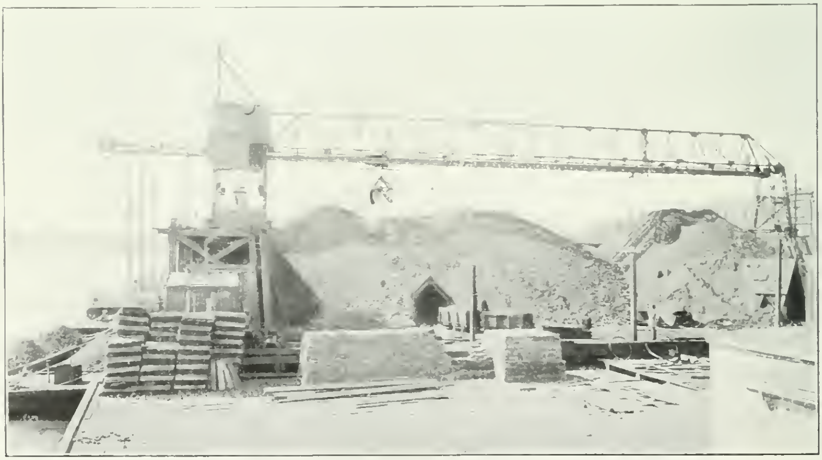
The chief wearing part is the rope. As an example of the life of a



SELF-CONTAINED PORTABLE BELT CONVEYOR.

24-ft. conveyor, with small direct-connected engine mounted on 35-ft. steel truss. For cellar excavation, unloading vessels, etc. Robins Conveying Belt Co.

plant of this character an instance can be cited of a line in Spain, constructed on this system, carrying 500 tons a day over a mile length, where the rope carried over 160,000 tons, representing an outlay of about ¼d. per ton per mile for rope renewal. Including all renewals, but not figuring on fuel, the average cost for transport per ton per mile works from 2d. to 4d.

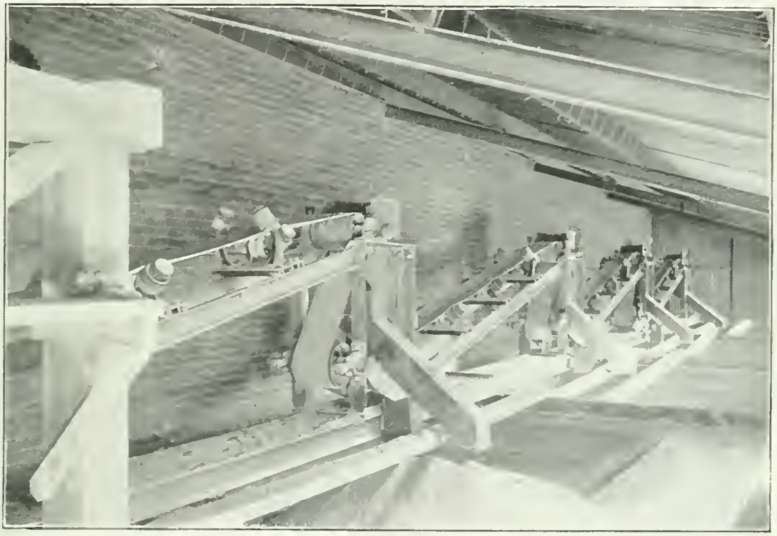


COAL-HANDLING PLANT, WEST END STREET RAILWAY COMPANY'S WHARF, BOSTON.

The plant is operated by an electric hoist, and equipped with self-filling clam-shell buckets and Miller-Covell double-swing fall-rope carrier for supporting the slack ropes.

(*2.*) Endless ropeway with hanging carriers rigidly fixed and moving with rope; this does work similar to that performed by the first type and is especially suitable for working over steep inclines with many and sudden changes of level. Unloading can be performed automatically by a catch bar striking the carrier and opening or tilting it. It is difficult to load, the operation being accomplished by complicated and more or less ingenious devices to fill the buckets while going round drums or at a point adjacent thereto.

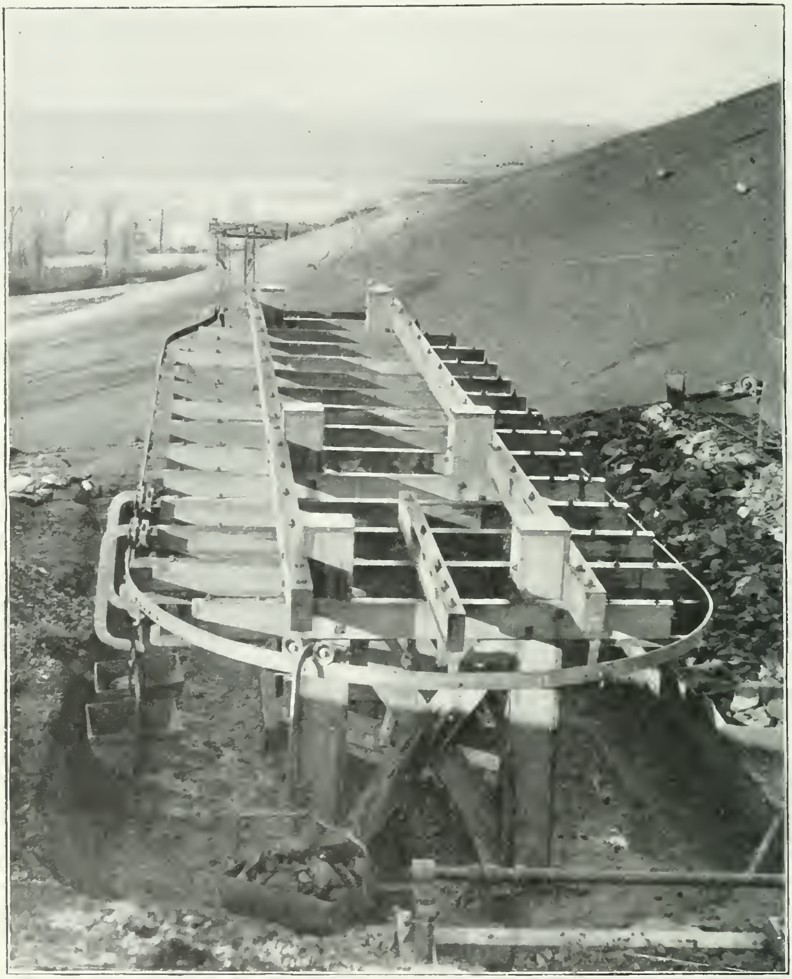
It is not unusual to have an arrangement of loading hoppers travelling at the same speed and actuated by the rope. Complications can be avoided by making the rope run at speed approximating 2½ miles an hour, which renders loading simple and dispenses with automatic gear.



CONVEYOR WITH AUTOMATICALLY REGULATED DISCHARGES. NEW JERSEY ZINC CO., HAZARD, PA

Four fixed trippers automatically fill each bin in turn. As soon as a bin is full the material backs up in the spout and returns to the belt, which carries it to the next tripper, and so on. The discharge can also be manually regulated by cut-offs. Robins Conveying Belt Co.

(3.) The endless fixed carrying rope and endless moving drawing rope, for employment where the quantities exceed 400 tons a day, and for overcoming difficulties which system No. 1 cannot surmount. While it is economical in wear and tear, the initial outlay is sometimes large. On one line constructed on this system, the power generated by descending loads was so great that it was necessary to absorb the greater portion of it and the difficulty was overcome by the introduc-

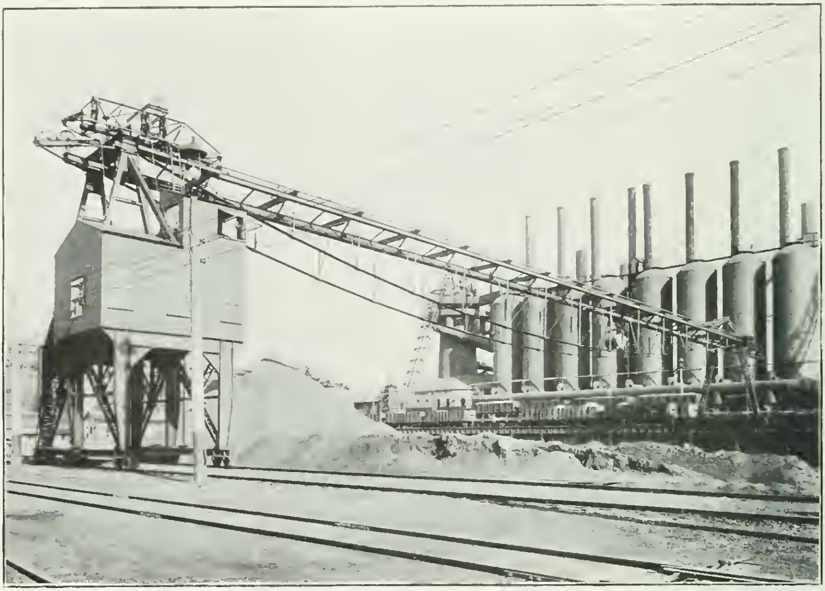


ROPEWAY IN WARWICKSHIRE FOR CARRYING IRONSTONE.
The capacity is 200 tons per day. The view shows the method of loading.

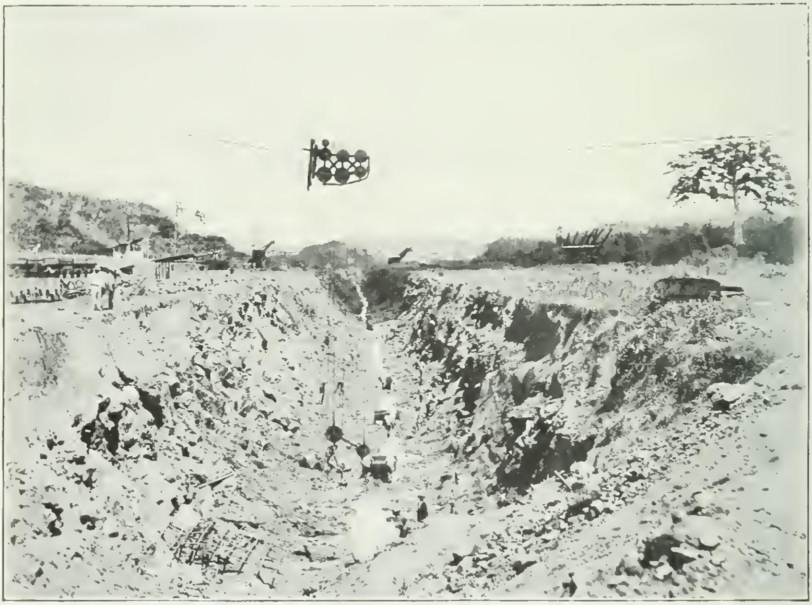
tion of a water brake, in which a revolving fan drove the water against fixed vanes which again repelled it, and thus about 50 h. p. was absorbed and the ropeway was rendered amenable in speed, with the control of a hand brake, being regulated to a nicety by adjustment on fixed vanes against which the water impinged. To keep the temperature of water employed in the brake sufficiently low a small supply of cold water was provided.

(4.) A single fixed rope on which one carrier is drawn to and fro with an endless hauling rope, the driving gear having reversing motion so that the direction of travel of the carrier can be controlled. It is suitable for handling large quantities over short distances—viz., 400 tons in 10 hours—with terminals about 450 ft. apart. The ropeway on this principle located at Table Mountain is an important example of a line 5,280 ft. long. Commencing at sea level, and following the ground

THE TOP OF THE TABLE MOUNTAIN RAILWAY.
Showing the steep incline and beginning of 500-ft. span to first support. Bullivant & Co.



ANOTHER VIEW OF THE DUQUESNE ORE-HANDLING AND STORAGE PLANT.



AMERICAN CABLEWAYS AT WORK ON THE PANAMA CANAL.

The view is taken at Emperador, 32½ miles from the Atlantic, looking toward Colon.

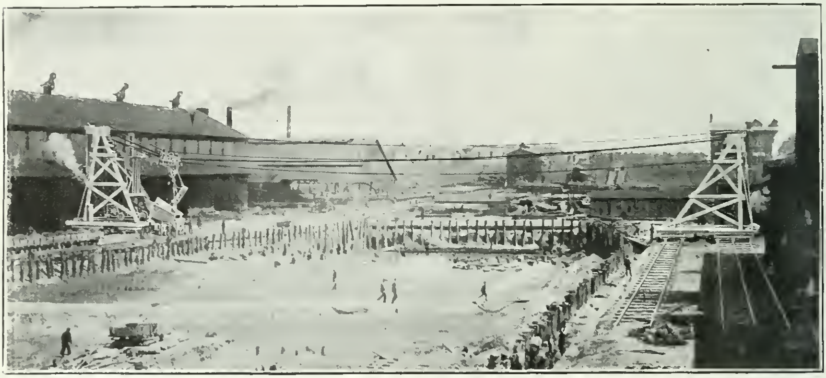
on posts spaced about 300 feet apart, the cable takes a span of 1,500 feet, rising to a projecting rock some 1,480 feet above the starting point. Resting on a support at this point, the cable again takes a span of 1,400 feet to an upper terminal 2,200 feet above the lower one. This ropeway has worked so satisfactorily that it is not only used for the carriage of materials employed in the construction of a reservoir, but is at times used for the conveyance of passengers.

(5.) The use of two fixed ropes, with an endless hauling rope, in which one carrier travels in one direction, while the other runs on a parallel rope in the opposite direction. This is a thoroughly serviceable type of tramway capable of being used over extremely long spans, and of carrying loads up to five tons. This system is one which is intermediate between the third and fourth, adopting the use of two parallel fixed ropes as in the third system, but with the use of one carrier on each rope as in the fourth system. It may be used where the quantities required to be moved are such as will admit of the ropeway being worked by gravity, one carrier descending loaded while the other carrier ascends unloaded. With this arrangement, long spans may be made without supports, loads up to 6 tons may be carried, and quantities up to 100 tons per day transported. In other cases steam power may be employed, and the loads moved from the lower to the upper terminal while the empty carrier descends loaded or unloaded as may be the case.

A PORTION OF THE WARWICKSHIRE ROPEWAY, SHOWING CARRIERS OF IRONSTONE IN TRANSIT.

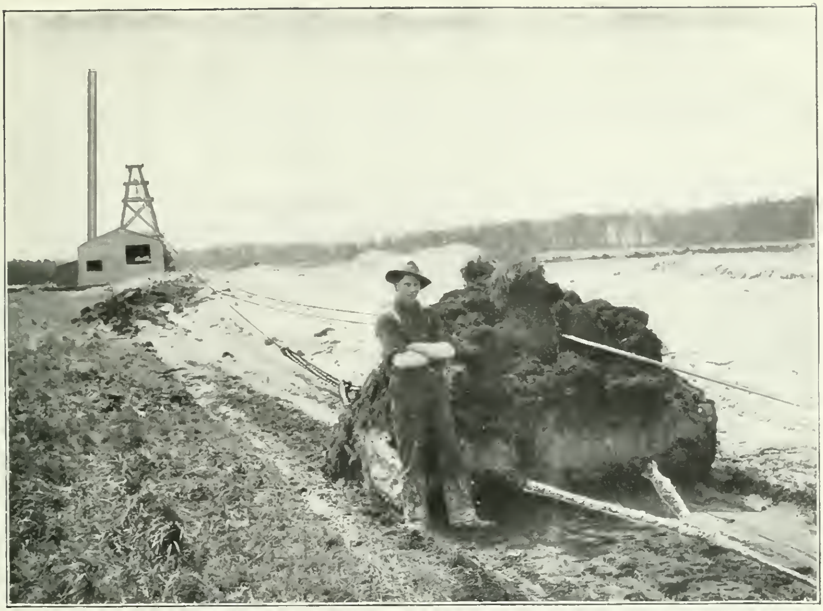
By the experience gained in the construction of a number of such ropeways, great efficiency has been arrived at, so much so that these ropeways may be relied upon to provide a safe means of transport for passengers, and the speed at which the carriers run can be very great, indeed not infrequently amounting to thirty to forty miles per hour. The control of the line is effected by a brake gear situated at the upper terminal, operated by one man who can perfectly regulate the speed.

(6.) The use of one fixed rope placed on an incline on which carriers, from which are suspended loads, are allowed to run down uncontrolled one at a time. This is generally called a "shoot." This system is simple, and used for the transport of undamageable goods. It consists of a light wire rope stretched between two points, the elevation of one being considerably above that of the other. On this, loads from 1 cwt. to 4 cwt. hanging from a runner carrying one or two wheels, are allowed to run down uncontrolled. The shock can be lessened by regulating the sag of the rope where the levels of the ground will admit, so as to reduce the speed of the runner with its load as it approaches the lower terminal. This type of ropeway is largely used for the carriage of firewood, coffee, or other like materials. Spans can be made without support up to 7,000 feet, and all that is required for fixing the rope is a good anchorage at the upper end, and another with a tightening gear at the lower end. Ropes for this purpose up to 3,500 feet spans are used, made in the form of a strand; above this, in order to obtain the necessary strength with a moderate size of wire, ropes are used consisting of several strands formed each of several wires. The runners have wheels of small diameter, and are made as



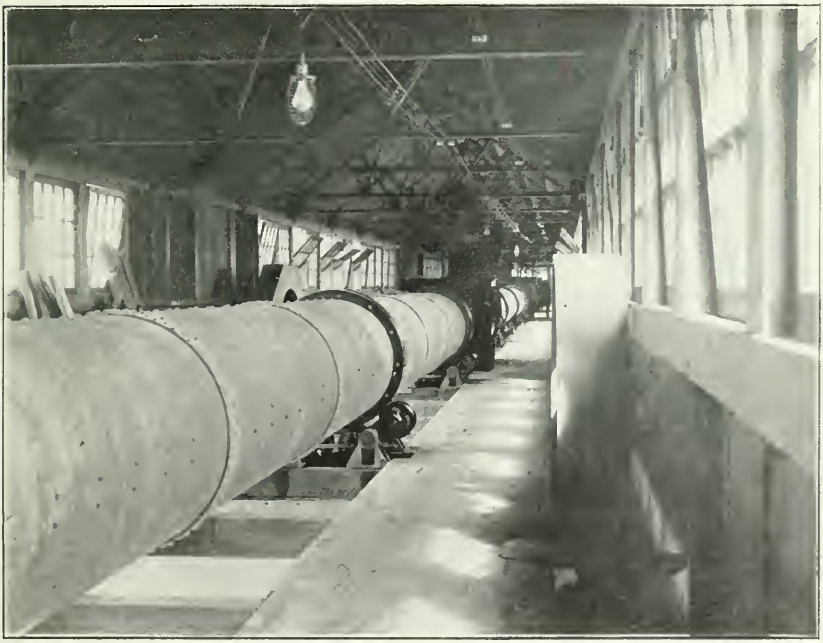
CABLEWAY AT WORK ON EXCAVATION FOR DRY DOCK AT NEWPORT NEWS.

The span is 275 ft., and the movable towers between which the cable is suspended are about 35 ft. high. Skips are filled by hand and discharged automatically. Lidgerwood Mfg. Co.



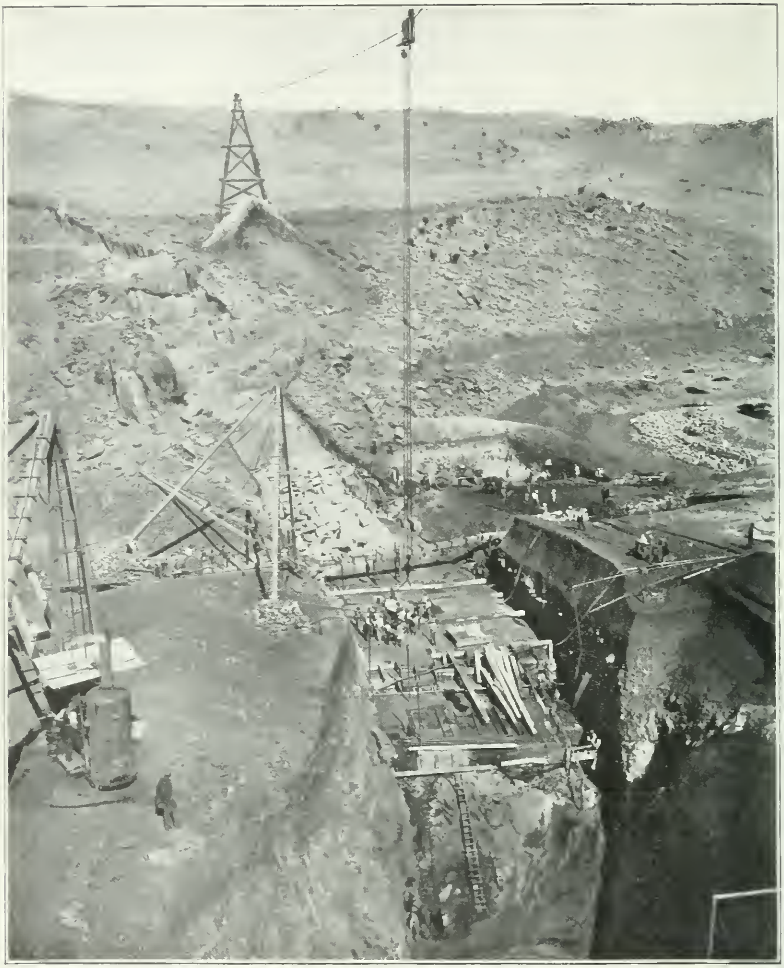
MECHANICAL TRANSPORT OF SPOIL IN DIGGING A WATER-POWER CANAL.

The heavy drag-rope at the bottom moves the loaded scoop; the upper endless ropes serve to set the scraper in position and to trip it when it reaches the spoil bank. Span, 725 ft.; face of excavator, 7 ft; worked by 75 h. p. engine. Lidgerwood Mfg. Co.



STEEL ROTARY CONVEYOR FOR CARRYING AND COOLING SODA, CEMENT, ETC.

A continuous spiral steel blade is attached to the inner surface of the cylinder, which is revolved by power-driven gearing placed on the outside. Link Belt Engineering Co.



BUILDING A DAM FOR THE CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA.
Lidgerwood cableway used for excavation and for placing of masonry.

light as possible in order that, after 50 or 100 loads have been delivered, the empties may be returned for more material.

The applications of this system are too numerous to recite. They are dotted over Aberdeenshire as thick as the double-strand noria bucket pumps in use on the continent. Probably many hundreds of miles are in operation, and with a rope or strand of suitable material and strength, together with well made runners, the carriage of such material as can be treated in the manner named above is alike efficient, economical and speedy.

PROGRESS IN AUTOMOBILE CONSTRUCTION.

By W. Worby Beaumont.

WHEN I wrote on the horseless carriage industry, in THE ENGINEERING MAGAZINE for September, 1897, I remarked that "the motor-car industry in Europe to-day affords a remarkable illustration of the great distance or difference there may be, and usually is, between a 'good makeshift' and a thing which is so far on the road to practical perfection that possible improvement is not obvious on inspection. In the motor-car the difference has been, and is, chiefly in mechanical imperfection."

During the two years which have passed since then the essential lines of construction have received no radical change. In such highly successful vehicles as those of Panhard & Levassor, of Peugeot Frères, and of Benz, two years have not pointed the way to any necessity for such change; but they have been marked by very great strides in the removal of mechanical imperfections. The memorable feats of the vehicles of Panhard & Levassor, of Peugeot, and of Mors in the Paris-Amsterdam race of last year, the Paris-Bordeaux race of this summer, and the Tour de France race, have been accomplished by the removal of mechanical defects shown by previous similar severe tests, by the adoption of higher and higher grade materials, by the adoption of methods and workmanship previously looked upon as too expensive for anything but standard tool-making, and by a minute attention to every indication of experience and every means of convenience.

A moderate, and even a large, increase in power does not necessarily mean anything like a proportionate increase in weight. Hence, very few of these new carriages are fitted with the small powers common in 1896-7, and for the faster vehicles four-cylinder motors of the Daimler type are used. They are fitted so that one, two, three, or four cylinders may be brought into play, and even these are made to run through a greater range of speed than was generally possible two years ago, the greater range being secured by more perfect carburation and admixture of the richly carburetted air and the supplementary pure-air admission and by the use of higher compression. Thus, with a wider range of speed in the engine itself, and with the permissive action of one or two pistons of a two-cylinder engine, or of one to four pistons of a four-cylinder engine, a degree of flexibility has been attained which, in the hands of an experienced driver, approximates that of a steam engine.

This change has modified the damaging effects on the spur gearing which were difficult to avoid when each change of speed was generally accompanied by heavy impact as well as by sudden increase of spur-tooth load. The spur wheels, or rings carrying the teeth, are made with great accuracy, of higher-grade material, and are hardened; and every bearing of a crankshaft is not only hardened but accurately finished by emery grinders to take out every trace of the frequent effects of hardening. Now that it has become obvious that the motor-car has come to stay, the experienced mechanical engineer has come to the aid of the less experienced originator, and the high prices which the wealthy sportsmen of Europe are willing to pay for the best car have justified the best that can be used and that skill and experience can suggest.

More cylinders are used with less trouble than is involved in the use of more gear, and the demand for more power is answered by the admission that its provision is easy at a price, and that, the motor being provided, power is cheaper than most things.

The permissive use of one or more of the two or four pistons does not affect the governing, and the control of the governor itself, so that it may go into operation at different speeds or be cut out for the greatest acceleration, is effected by simple and convenient means.

This increase of power has been attended by comparatively small increase in the total weight of vehicle, and, in some of those which were more open to improvement, by no increase per seat provided. The employment of steel and of stamped forgings, in place of heavier castings, has helped in this, and the improvement in the constant-circulation water-jacket coolers has reduced the weight of water which formerly had to be carried. In some recent cases, by the use of light tubular coolers with the supply tank placed so that natural circulation can be used, the weight has been reduced over a hundredweight and the necessity for a pump avoided.

In the more recent carriages the objectionable smell from bad exhaust has been avoided by the means already mentioned for varying the quantity and place of admission of air (some of which may be warmed before admission) and by greater compression. The latter has been made possible by simple means adopted for holding open the exhaust valve during part of the compression stroke while starting the engine, the cam automatically returning to its normal place after the engine has started.

The higher speeds and the long distance runs over all sorts of roads against time have not developed the power side of the motor carriage alone. High propelling power demands high transmission power, beginning with the gearing, to which I have referred, and ending at the tires of the driving wheels. Here the limit of endurance of materials, employed in the best ways at present known, is soon reached—or so soon as to present one of the most troublesome problems for the motor-carriage maker and user. That spring wheel is best which puts the spring nearest to the point of incidence of the impact from which we want to shield the whole of the motor-carriage. The most perfect spring we can have is air under pressure, and a pneumatic tire is the best way yet known of putting that spring into use. Its use means a deformable envelope, which must be well and strongly made, capable of withstanding not only repeated deformation at high speeds, but under the worst possible conditions as to wear-and-tear by the cutting and abrading irregularities which effect the worst of the deformation under an insistent load. The envelope, moreover, must be easily detached and replaced, and capable of withstanding high tangential tensile stresses as well as the continuous stress due to an internal pressure of 50 to 80 lbs. per square inch. This very difficult problem has not been solved, though it has been met with considerable success by Michelin, in France, where the high-grade high-speed car has most persistently proved the speed superiority of the pneumatic tire over any other. In England the same success has not yet been achieved, but tires of the same form and method of manufacture are now being made. On this question it does not appear to be recognized, that, even with rubber, there is a limit to velocity of transmission of impact, and therefore a limit to the velocity of impact under which rubber will bend, or extend, and not break. The higher the speed, therefore, the greater the effect of road abrasion and the more frequent the conversion of an abrading stone into a cutting stone. Thus, the limit of endurance of the materials puts a limit upon both the speed and the weight carried, and the past year has probably seen the limit of endurance approached by the distinctive co-action of high speed and heavy weight. On the other hand, the same period of time has shown how highly enduring the same tires may be when only one of the two destroying causes is in action. Many of the motor tricycles have run thousands of miles at speeds which are second only to those of the fast racing cars, but instead of having a load of about 0.25 ton to 0.3 ton per wheel, their load is only about 0.07 ton per wheel, or, say, one-fourth of the load on a full sized racing car—enough to make all the difference between play and punishment. The attempt to use solid rubber tires for vehicles of heavy weight and high speed has also brought about numerous interesting experiments during the past two years. Some of the most thorough and most practical have been those of the Lifer company, which, with a steam wagonette weighing under 39 cwt. empty and 54 cwt. with fuel and water, has been running thousands of miles with from ten to fourteen passengers at speeds up to 30 miles an hour. With the best tires that can be got, about 3¼ in. wide between the turned-in flanges of the rim, a pair of tires will only last about 2,000 miles. At an average speed of 8 miles an hour instead of about 12, these same tires would probably last another 400 or 500 miles, and if they were endless and vulcanised on the metal rim they would probably run at least another 500 miles. With a weight of, say, 2 tons instead of 3½ tons, or 10 cwt. per wheel instead of 18 cwt., these same tires would probably have a life of over 4,000 miles.

The past two years have done much to put the mineral spirit (or petrol) motor vehicle at the head of all long-distance high-speed and high-endurance vehicles. The motors themselves, as already mentioned, have received many developing touches, and the greater convenience attending the use of petrol, as against kerosene, has not been in the least diminished. Attempts have been made in France to put on the roads a heavy-oil vehicle, but, inasmuch as the very soul of a kerosene motor is its vapouriser and feed and vapour-valve arrangement, that which was tried was doomed to failure for the variable work of an automobile.

In England Messrs. Roots & Venables stick to kerosene and have sent a few cars to hot countries, but their efforts have not been encouraged by the flattery of imitation. There can be no doubt that the oil of high flashing point has strong recommendations for countries so hot that gasoline is a continual source of danger or is unattainable, or for trading vehicles in which the lower cost of kerosene is a matter of importance; but for all light and pleasure vehicles. gasoline is, at present, much to be preferred on account of the greater cleanliness, the more perfect combustion and the easy control of vapourisation, the freedom from cylinder and piston troubles, and the greater control on the character of the exhaust on very variable work and stop-and-start repetitions of town work. It is, however, still conceivable that a feed of minute accuracy and a gasifying vapouriser with gas receiver and valve-controlled admission to cylinder may yet be made which, under all ordinary exigencies of interrupted working, will make the use of kerosene sufficiently unobjectionable.

In Europe the past two years have seen very little of development of the steam carriage. Most of that time M. Serpollet, to whom all turn in expectation, has been too much occupied in the completion of the Serpollet tram cars of Paris. That being accomplished, he has now returned to the steam road carriage and in conjunction with M. Gardner is building a large number of the carriages of his most recent form, similar to those exhibited in the Automobile exhibition in Paris last summer, and in London in July. He is now using a small spiral-tube Serpollet generator and a motor with mushroom valves, operated by cams on a shaft which can be moved laterally, so that cams for either direction of rotation can be brought into action at will for reversing, the motor being very simple in construction. These carriages have not, however, taken part in any of the recent contests and their power and endurance remain in this sense to be proved.

In England the successful steam vehicles are of a heavier kind, such as the wagonette referred to already and a much lighter vehicle on the same principle and lines by the Lifer company—*i. e.,* the Liquid Fuel Engineering Company. The boiler used by this firm consists of series of rings of closely packed vertical tubes, slightly bent to give them all about as much spiral bend as the grooves in a large rifled gun, the lower ends of the tubes being fastened by unions, below the level of the hot flame from the powerful kerosene burner employed, into an annular water chamber. The upper ends of the annular forest of tubes are bent and fastened by unions radially in a vertical, cylindrical, water and steam vessel. This boiler gives excellent practical results, and gives dry steam to the small horizontal double-cylinder compound reversing engines which are carried in a complete underframe separate from the car body, the whole drive being by spur gear. Chains have been discarded, more particularly for the heavier wagonettes. The same firm has achieved much practical success with heavy trading lorries and vans, as used by brewers and others. Other firms, including the Steam Van and Wagon Co., have achieved success with the heavy classes of vans and lorries on the Thorneycroft system, the weight being not more than 3 tons unladen and without fuel and water. These vans carry as much as 4 and 5 tons, and in trials under the Automobile Club at Richmond, and by its Liverpool branch on roads surrounding Liverpool, they behaved this year with great success. Both the Lifer and the Thorneycroft were subjects of trial during the meeting of the British Association for the Advancement of Science at Dover last September, when, as at Richmond, the author was one of the judges. With loads of 3, 4, and 5 tons, these vehicles made excellent runs on roads of varied character and considerable grades, one man manipulating them with marvellous facility.

Another sign of the times was the two heavy-load lorries exhibited at the Richmond show and tested by the Automobile Club last June. These were made by the Cannstadt Daimler Co., one fitted with 6-h.p. and the other with 10-h.p. petrol motor. One carried 3 tons and the other 5 tons. They went through the trials in admirable style and were manipulated in and out of yards and sheds with at least as much facility as the steam cars. They were operated by one man, while some steam vehicles require two, and the cost per ton-mile of load carried for the oil used as fuel was only 0.33d., while the water required was nominal.

A great deal has been done in the two years in the development of the electric vehicle of various types, and the result of the two years' work seems to be that, for town work and short radius runs, they are satisfactory and pleasing as to smoothness and quietness of running. They meet the requirements of those who do not wish to run more than 25 to 30 miles per day, of runabout work, and of those who do not study the cost either of vehicle or of running or maintenance. The secondary battery is still a thing of delicacy, which can soon be ruined by inconsiderate drivers who would use a starting switch as they would use a steam valve, and it is also a thing which is far more durable as a fixture than when used even in the most comfortably sprung automobile. As cabs, the electromobiles have failed in London; they are in a similar plight in Paris, and at present none of these electric vehicles appears likely to take the place of horse vehicles in commercial work.

Another sign of the times is the fact that, although a number of automobile sportsmen have ordered racing cars of high power from some English makers of gasoline-motor carriages, at least one admirer of the steam engine for such purposes has failed to get, from the most esteemed builders in England, a tender for a steam carriage of similar power. The Daimler motor may be said to hold the field, and some indication of the similar state of things in France and Germany is the fact that the Panhard & Levassor Co. have on hand now orders for over £600,000 worth of carriages, and both the Cannstadt and the Benz companies are building cars to seat two or four, with motors of from 16 to 24 h. p. for fast running and high-speed hill work, and all makers have more than they can do.

A departure from the general lines of automobile-carriage construction which is very popular has marked this year's output of many builders—namely, a smaller vehicle to carry two persons and fitted with a 4-h. p. or a 6-h. p. motor. MM. Peugeot Freres, MM. de Dion & Bouton, M. Decauville, MM. Daracy & Bollée, and several others on the continent and in England are making these cars and find a large demand at about £200. Many of them are fitted with the still smaller motors of the de Dion type, used for the more powerful tricycles, but the Peugeot and the de Dion two-seated voiturettes have larger motors with water-jacketted cylinders.

The development of the electric two-seated victoria and other carriages in the United States has attracted much attention in England, but at present the vehicles capable of long distances with a few pints of oil occupy the most attention, and charging stations are not numerous yet, and, even when they are, charging takes a long time.

The light steam cars of Whitney and of Stanley have also attracted much attention, but the benzoline used as fuel is very costly and not quite so harmless as when used in the internal-combustion motor, which requires so very much less water, or none at all. The boiler, like the other parts of these cars, is a highly meritorious and high-bred kind of thing, requiring, perhaps, more attention than it is likely to get willingly in Europe, where, at the end of a hundred mile run, the car is likely to have no more attention than to have its lamps put out, the oil and lubrication stopped, and then to be allowed to remain until the morning. This would not suit a boiler with tubes ⅛ of an inch apart which had been running all day on chalk-district water. These carriages are, however, at present so light in total weight that boiler and everything else could be increased in size, weight, and strength and still be able to run fast on pneumatic tires.

Lastly, as evidence of the growth and importance of automobilism, I may mention that the Automobile Club of France has nearly two thousand members, and the subscription is £8 per year; the Automobile Club of Great Britain has now nearly six hundred members, and active automobile clubs have been formed in Germany, Austria, Italy, Belgium and elsewhere.

The big company-promoting business is practically dead, and those companies which are formed now have nearly all their capital as working capital.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

IV.—THE LIMITATIONS OF TOOL-MAKING.

By Henry Roland.

IT has been clearly shown that if the human race continues to exist and to advance in morals, comfort, and elegance of living, tool-making must begin and must be carried to what now appears to be a high development. What is the limit of the tool-maker's art, and when and where should or must tool-making stop?

Commercially speaking, it must stop in any particular case when more tool-making cannot cheapen the total time cost of production; if the demand for the product is unlimited, then the only limitation in tool-making is the limit of human understanding and mechanical resources. When the tool-maker cannot further improve the quality or lower the cost of the product, then, very clearly, the end of his usefulness in the particular case has come.

If the demand for the product is limited, and cannot be enlarged by bettering the product and reducing its selling price, then there is a total remuneration to consider, and the limited total remuneration must limit production expenditures, tool-making included.

Broadly speaking, it is conceivable that in some special production tool-making may be carried to a point where no farther profitable advance can be made, and it is also conceivable that there may be things useful and desirable to the few, which cannot by improvement of quality and lowering of cost be made useful and desirable to the many; but it is extremely difficult to select examples illustrating either of these propositions. Speaking narrowly from existing facts and conditions, it seems probable that the limit of tool-making has never been reached in any particular case.

Suppose an article to be produced wholly by automatic machines, so that its cost does not include any direct labor. It was Spencer's custom, when he first set a few of his double automatic screw machines at work making screws from large coils of wire, to lock up the room and go away and leave the machines wholly unattended for a considerable period of time, perhaps almost as long as the stock would last, and it was the rule for him to find all of the machines still at work when he again unlocked his factory door. Here is an actual case where labor

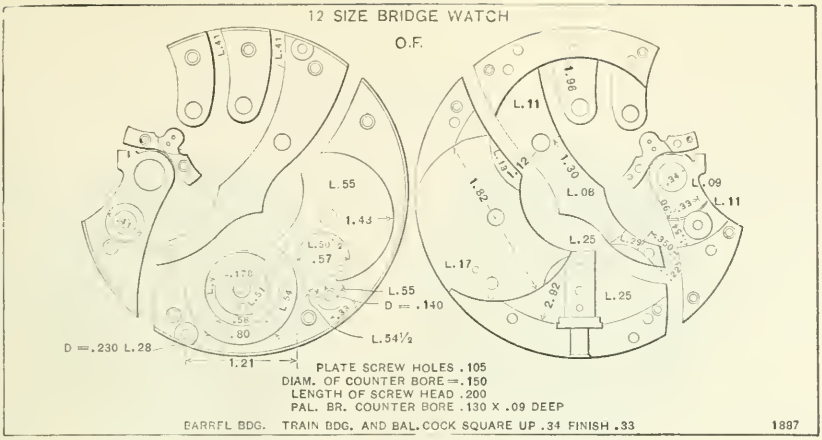


PLATE SCREW HOLES .105
DIAM. OF COUNTER BORE = .150
LENGTH OF SCREW HEAD .200
PAL. BR. COUNTER BORE .130 X .09 DEEP
BARREL BDG. TRAIN BDG. AND BAL. COCK SQUARE UP .34 FINISH .33

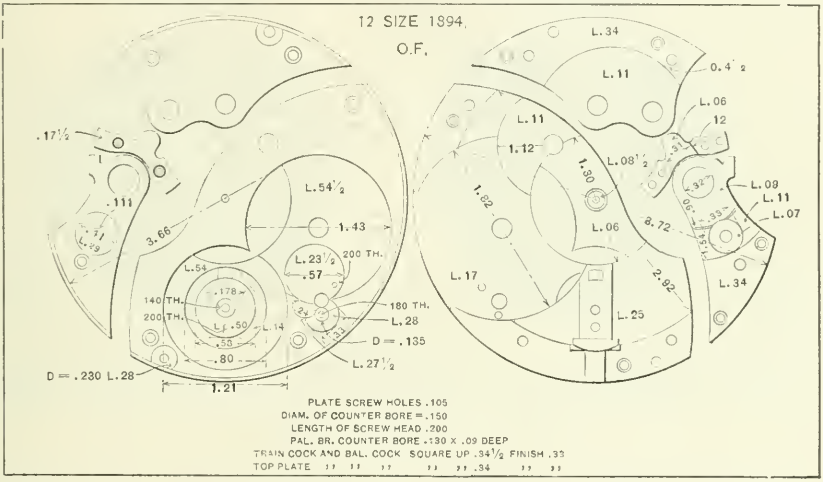
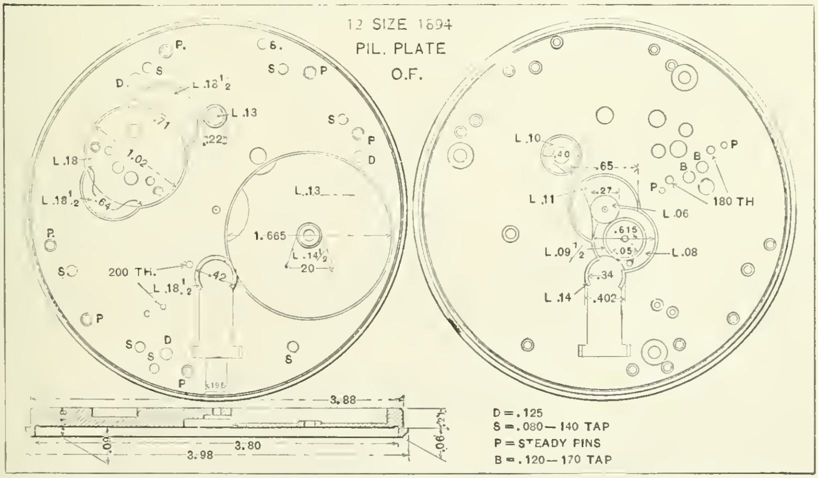


PLATE SCREW HOLES .105
DIAM. OF COUNTER BORE = .150
LENGTH OF SCREW HEAD .200
PAL. BR. COUNTER BORE .130 X .09 DEEP
TRAIN COCK AND BAL. COCK SQUARE UP .34½ FINISH .33
TOP PLATE ,, ,, ,, ,, ,, .34 ,, ,,



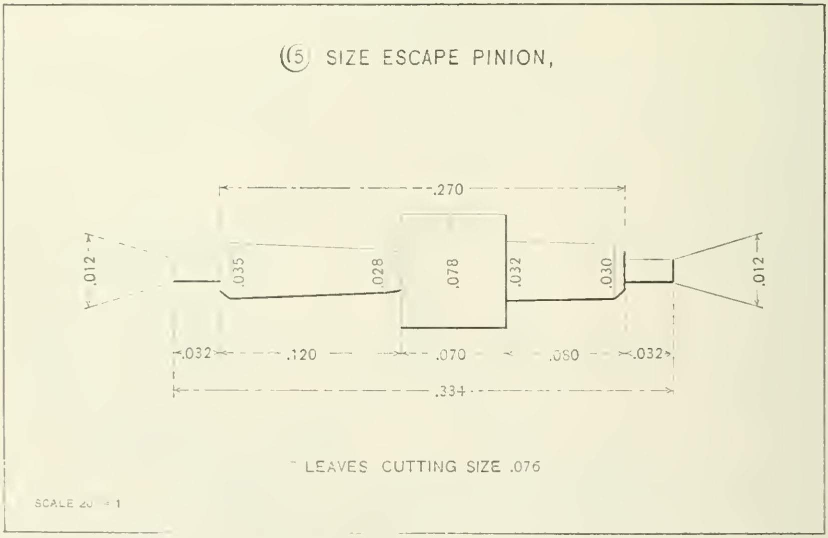
D = .125
S = .080—140 TAP
P = STEADY PINS
B = .120—170 TAP

THE LOWER TWO CUTS SHOW "12 SIZE PILLAR PLATE" AND THE BRIDGES AND COCKS CONSTITUTING THE TOP PLATE OF A MACHINE-MADE WALTHAM WATCH. THE UPPER CUT SHOWS A TOP PLATE OF MORE OPEN ARRANGEMENT. ALL ARE MADE ENTIRELY BY THE AUTOMATIC MACHINERY DESCRIBED IN THIS ARTICLE. DIMENSIONS ARE IN DECIMAL FRACTIONS OF A CENTIMETER.

cost was wholly eliminated, but this does not stop tool-making in that direction. No automatic tool is so good that it may not be bettered, and a machine which seems a miracle of perfection to a casual observer may be well known by its builder to be susceptible of great improvements. All cases of tool-making seem to fall into the common conclusion that, since perfection is beyond finite powers, tool-making can never end even in one particular case.

In practice, tool-making does end, as a rule, when the production cost is lowered below that of competing makers; but if the competitor improves his tools and lowers the previous lowest production cost, then others must do more tool-making or fall behind the trade.

In the case of unlimited demand and open competition in production, which is the general case of manufactures at large, tool-making may be carried to any extent. As an example testifying to the truth of this proposition, this paper will be devoted to an exhibition of the various tools which have been devised for drilling the little holes in watch plates—the plates of a watch being the two circular flat metal pieces, separated by short posts, which support the machinery of the watch, or one single completely circular plate supporting the various bridges and cocks which take the place of the second full plate. It may be said here that, broadly speaking, there is no other thing in common use farther from being an essential feature of human exist-



WALTHAM MACHINE-MADE ESCAPE PINION. SCALE, 20 = 1.
Dimensions are in decimals of a millimeter.

FRONT AND BACK OF TWO PATTERNS OF "12 SIZE" WALTHAM WATCH PLATES.
ACTUAL SIZE
The plates, as photographed above, are made complete from punched blanks, drilled and tapped wholly by automatic machines, and bear no hand work whatever.
The plates above were assembled at random from finished parts.
In this condition they cost about 8 cents apiece.

ence and comfortable living than is a watch. Yet, solely through the efforts of the tool-maker, the watch has become one of the first necessities of civilization, the demand is unlimited, the trade must always be in the hands of those makers who have the best tool-makers, and the watch parts are so small that automatic machines of every sort may possibly be applied to their production. Hence the watch-tool making does, as might be expected, furnish the most advanced examples of the tool-maker's art.

Holes are made in the watch plate and bridges and cocks, and these holes locate the various parts of the watch machinery and sustain them in fixed relations with one another. It is obvious, on a moment's reflection, that these watch-plate holes must be alike in location in each watch of a certain pattern, otherwise the watch parts will not be similarly placed with regard to one another, hence cannot similarly affect one another, and consequently the watches will not be uniform in action. The first watch plates were, of course, drilled with holes located by the hand of the workman; having produced one satisfactory

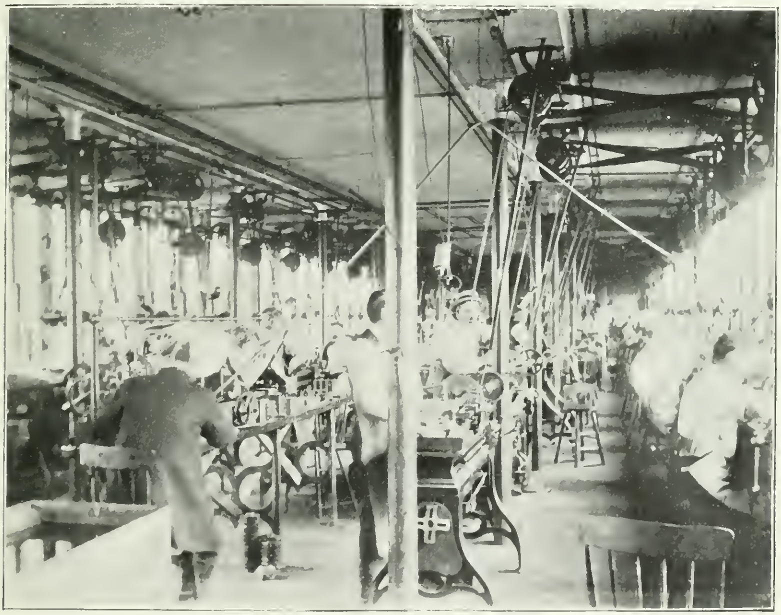
DUANE H. CHURCH.

The picture was taken without his knowledge, as he was intently watching a new automatic serial numbering machine for numbering watch plates in sequence.

watch by hand operations, the next step in advance was to duplicate this by the use of machinery, as it is impossible to lay out and drill two watch plates exactly alike by hand.

The most natural and obvious expedient for locating several holes in the same relation to each other in different pieces of metal is what is known among tool makers as the "jig." The jig for drilling holes is a metal structure having two essential elements of precision; first, it must hold the pieces to be drilled in a fixed and unchanging relation to itself, and second, it must be pierced with holes whose centres correspond accurately with the centres of the holes which are to be produced in the work. The holes in the jig may be the same size as the holes to be made in the work, or they may be larger than those holes, and these large jig holes may be used to take short cylindrical or cone-shaped pieces of hardened steel, called "bushes," the bushes being pierced with holes as large as, or larger than, the holes to be produced through their use. Each drill to be used with a jig must have a part of its body to fit a jig hole or bush, and a drilling jig is used by clamping the jig and the work together, and then passing a drill, guided by a jig hole, through the work. As the drill must be free to turn in the jig or jig bush, or else the jig bush must turn in the body of the jig to permit the drill to rotate, it is evident that there must be some degree of clearance between the drill and its guide, and this clearance is the first element of uncertainty in jig drilling. Again, there is great friction between the jig and the drill body, which soon makes the drill loose in the jig, and so makes inaccurate work possible. The jig is, however, very largely used in drilling both heavy and light work, and the watch-plate holes at the American Waltham factory were all drilled through jigs up to the time when Mr. Duane H. Church began his direction of methods and means of metal working at these shops in 1890.

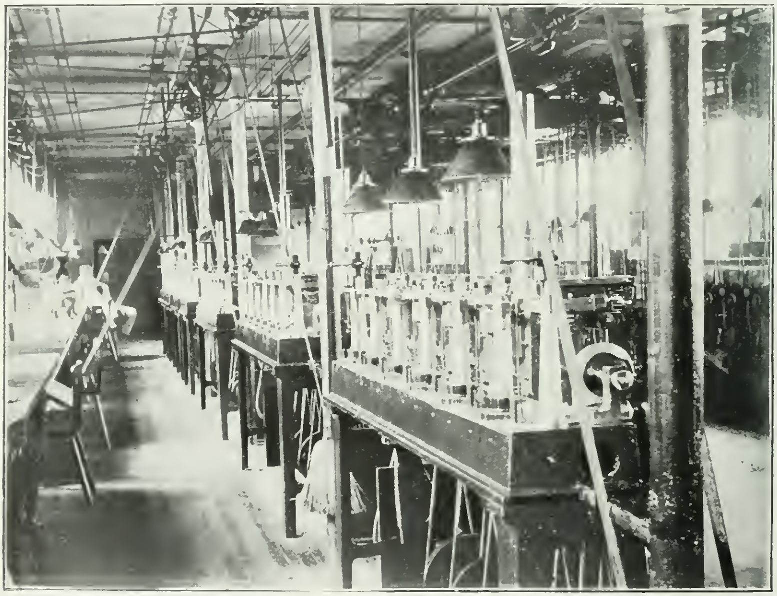
It may be said, probably without dispute, that the Waltham watch shops have gained their superior position mainly through the clear previsions and wonderful mechanical resources of Church, all of whose work is patented, and so, though freely exhibited to rivals, not open to their use. But, if there were no patents in the way, imitators and followers in matters of tool-making are hampered by time limitations which cannot be evaded, so that it is, perhaps, impossible for copyists to be nearer than, say, ten years behind the successful origi-



GENERAL VIEW OF ONE WING OF TOOL-MAKERS' SHOP, WALTHAM WATCH WORKS.

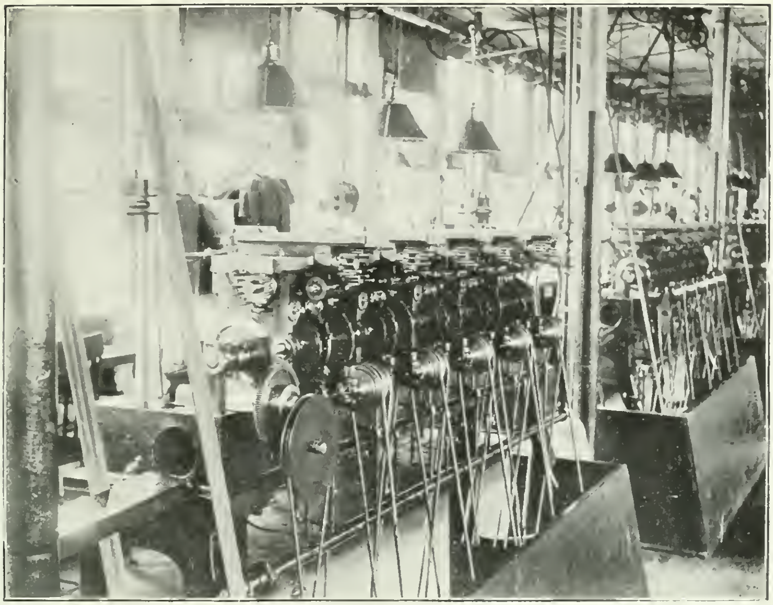
nator of new methods and tools used in machine part finishing, where, as in the work of Church, absolutely new methods and effects of the highest advantage have been devised and carried into wholly successful operation.

Duane H. Church was born in Madison County, New York State, in 1849, and at the age of sixteen began his apprenticeship as a watch maker under the instruction of J. E. Gridley, of St. Paul, Minnesota, whose constant admonition to the young mechanic was "Never leave a piece of work until you have done the best you can do"; Church said that he believed his own success was largely due to having this injunction so often repeated to him by Gridley, who was most conscientious and highly successful in his vocation. The words may have furnished a formula expressive of the dominating motive of his work, but even a slight familiarity with what he has done is quite sufficient to convince the observer that Church could not possibly construct a new tool which was not very much superior, both in general conception and in details, to all that had gone before. After completing his work under Gridley's instruction, Church worked for seventeen years as a watch maker

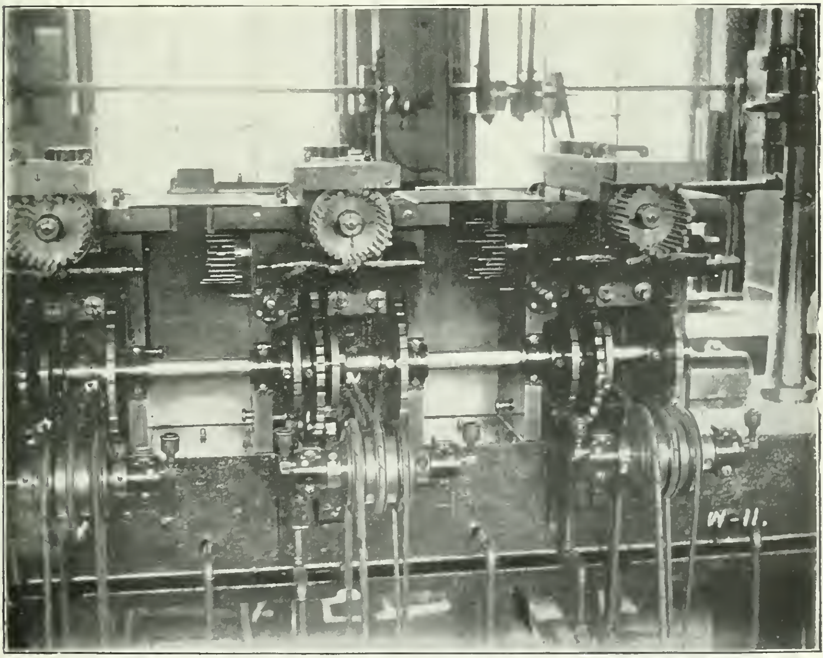


FRONT VIEW OF PLATE-DRILLING AND TAPPING MACHINES.

Transfer arms in front; three 6-head and four 2-head machines. There are in the factory altogether fourteen machines, doing the work for 2,500 watch movements per day, handling 12,500 separate pieces and performing about 405,000 operations. The attendant is seen in the extreme rear.



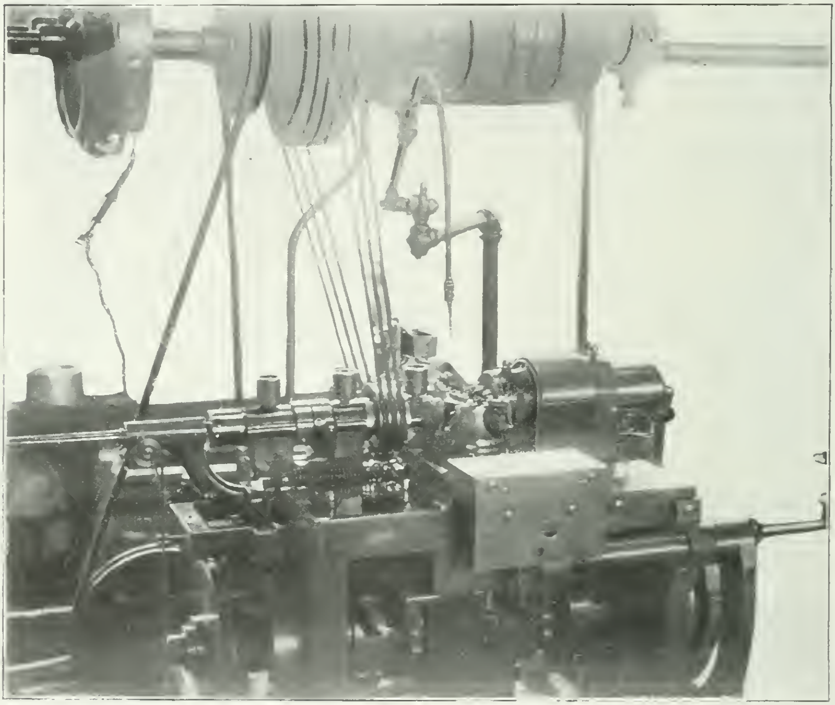
LEFT REAR VIEW OF PLATE-DRILLING MACHINES.



A PART OF THE REAR OF THE PLATE-DRILLING MACHINES.

Showing the stops for stopping the plate holder in two directions, at right angles, so that a hole may be correctly located at any point in the plate. Shows also the cams operating the air-admission cocks, and the two-speed countershafts.

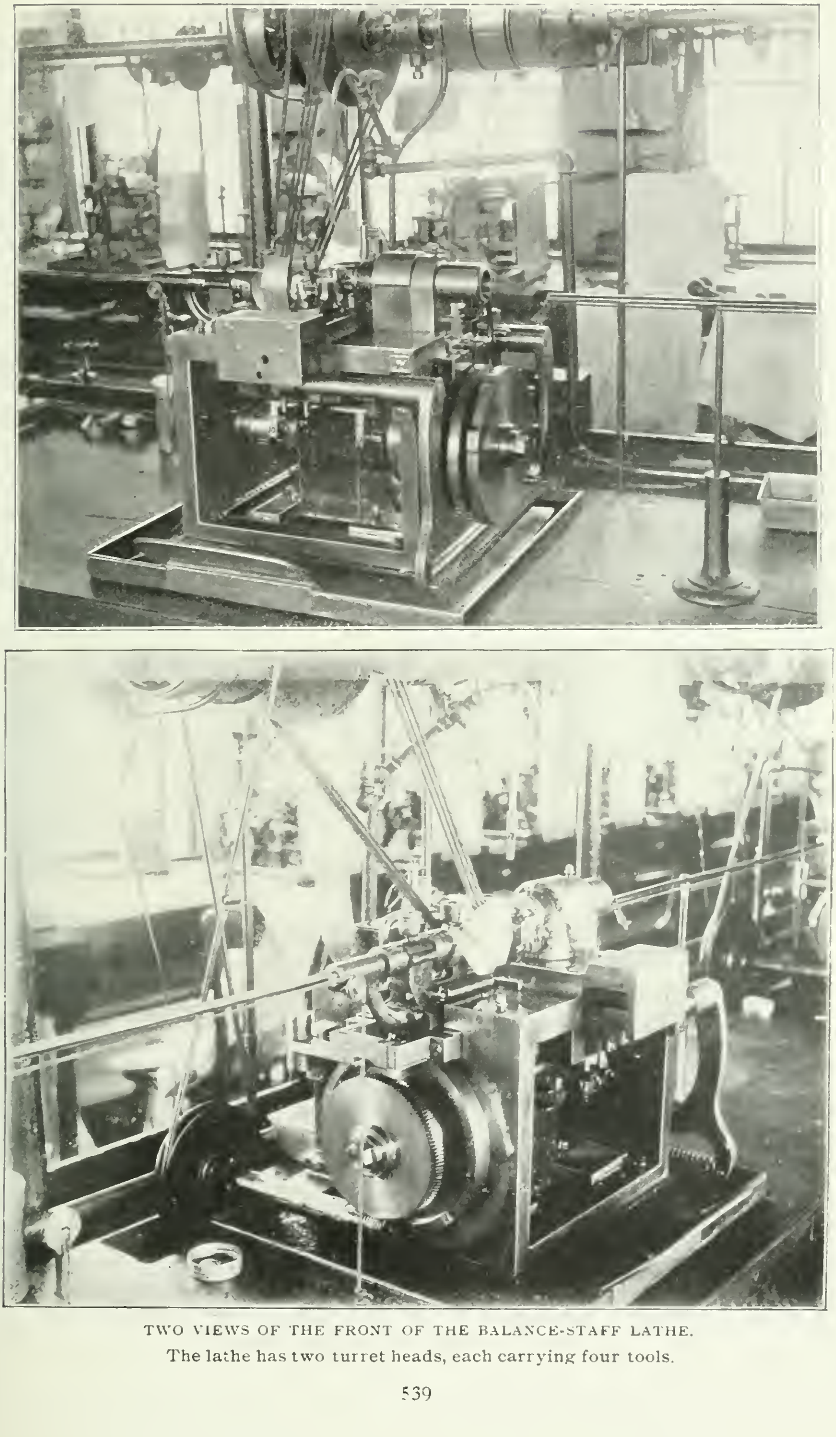
at the bench, principally for Matson, of Chicago, and for St. Paul establishments, all of this time giving no hint of his latent powers as a tool-maker, though he was accounted one of the best of watch repairers; finally he attracted the attention of the officers of the Waltham company, which at that time needed the best watch makers obtainable, and entered its service, first traveling one month on the road in "missionary" effort, asserting machine-made watches to be superior to all others—a proposition much more nearly true now than it was then. Next he was for another month in the Boston office of the company on experimental work, and finally, in 1882, reached the factory and at once took the position of master watch maker, which he held for eight years, during which he greatly improved the general design of the watch movements and devised the highly important form of pendant setting watch which enables stem-winding movements to be placed in cases not specially fitted to them—the most valuable feature, commercially, ever applied to watch construction.



FRONT VIEW OF BALANCE-STAFF LATHE.

Makes a complete balance-staff as shown in the engraving on page 543.

Finally, after twenty-five years of intimate association with watch



TWO VIEWS OF THE FRONT OF THE BALANCE-STAFF LATHE.

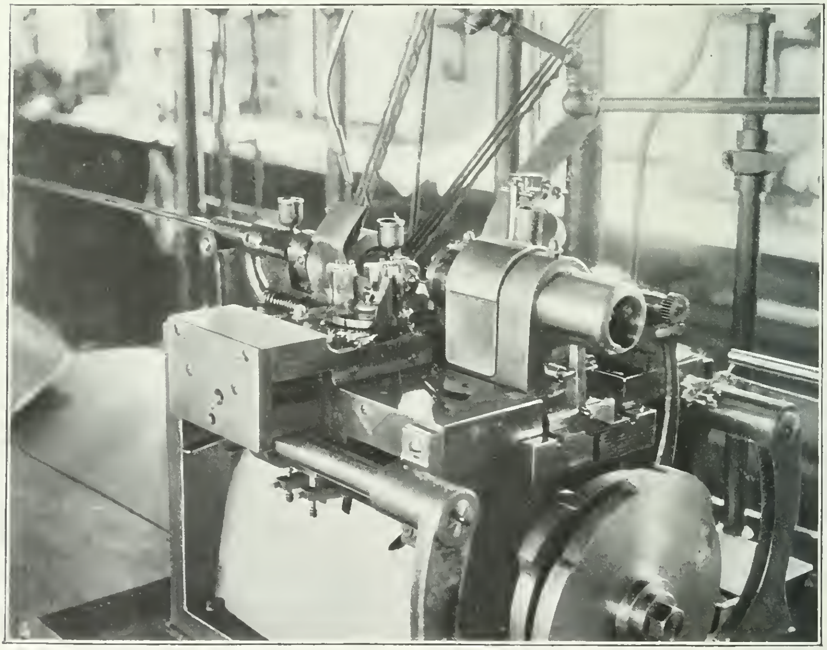
The lathe has two turret heads, each carrying four tools.

making in all of its forms, Church began his great work of advancing the use of Maudslay's slide rest and Stone's turret to what is now by far the most exalted plane of development known, and giving those elements powers which appear impossible of farther advancement.

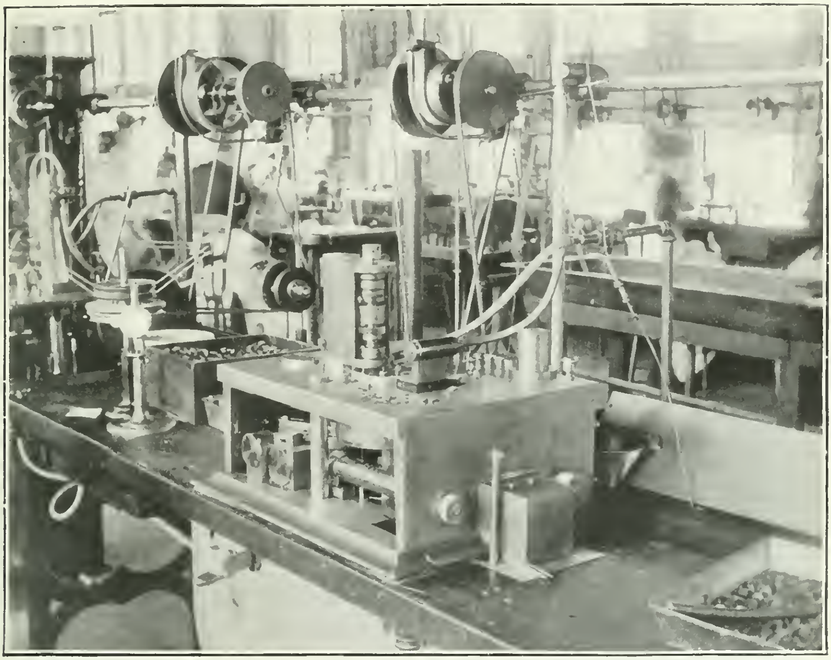
Some of his machines are shown in the illustrations given herewith, these tools being full automatics, and in all instances completing the piece produced before letting it go, no matter how many or how complicated the operations to be performed.

Church added to the slide rest and turret two new elements—first, that of compressed-air-driven piston-and-cylinder actuation of his automatic-machine members, and, second, a perfectly exact series of transfer elements, having the power to take a piece of work from one machine and place it accurately in another machine, with a beauty of action and precision of effect which seem to the experienced observer, when he sees these automatic machines in operation for the first time, to fall very little short of the miraculous.

In addition to the pneumatic and transfer elements, Church originated an automatic grinding machine, which produces cylinders and cones with absolutely no measurable variation in dimensions, wholly



REAR VIEW OF BALANCE-STAFF LATHE.

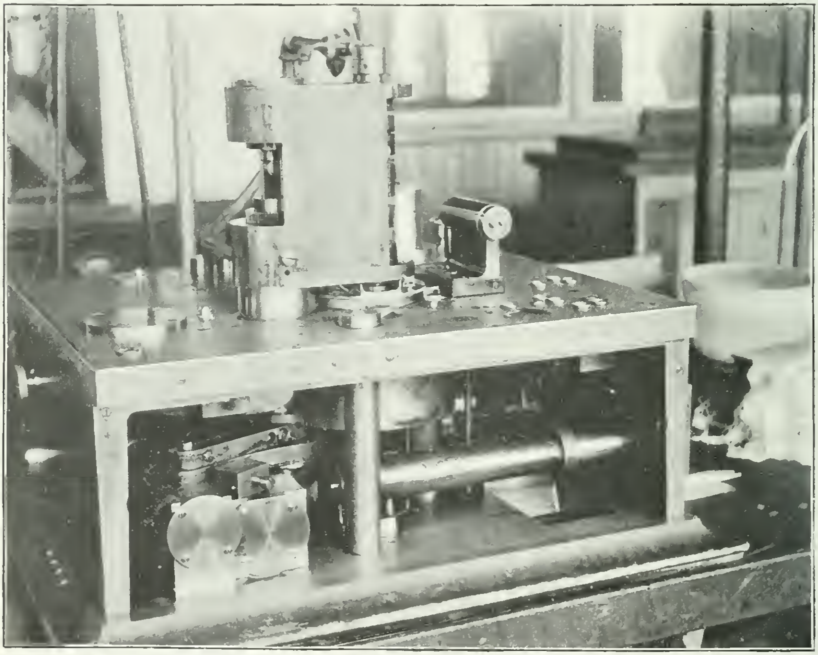


RIGHT FRONT VIEW OF AUTOMATIC GRINDING MACHINE.

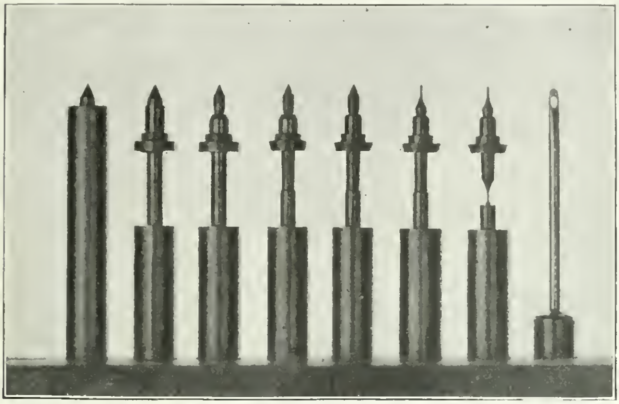
Fully automatic; will grind any desired number of separate surfaces on one piece at one setting. The work is absolute in dimensions.

without human intervention, and at a saving of at least three-quarters of the cost of producing ground work under manual attendance. The production of cylinders of uniform diameter is an indispensable necessity of the highest development of tool-making, and this automatic grinding machine seems to me to have made one of the most wonderful advances in the whole history of tool-making. The possibilities of the machine are as yet almost wholly unknown to the world of mechanics, and apparently equally unappreciated, the tools not being in use anywhere outside of the Waltham shops, although the inventor is perfectly willing they should go into authorized general use. Space does not permit a full description of the machine. It may be said that the use of the grinding-wheel periphery as the effective abrading surface is wholly abandoned, grinding rings being used in place of grinding wheels, and that the grinding ring is advanced toward the axis of the work in process of grinding until its working surface touches a diamond, when the machine draws the ring back, removes the ground piece of work from the machine, places another piece in position, and starts the ring to grinding it. This machine is adapted to be used on work of any ordinary size, and can produce true cylinders and cones at far less cost than anything else known.

When Church took the position of superintendent of tool-makers at the Waltham factory, the theory of step-by-step production was in force. There were roughing cuts and finishing cuts on the same piece, made in different machines and involving separate handlings. Church had become fully convinced that the cheapest and best method of machine-part finishing was formulated in Gridley's admonition "Never leave a piece of work until the best possible effect has been gained"—that is to say, once a piece is in the grasp of an automatic machine it should not be released until fully completed. In the ten years during which Church has been in charge of the Waltham tool-making he has succeeded in carrying out this conception of complete production with only one handling in the making of many of the watch parts, the plate-drilling machines being the most impressive of all of his creations, because they are the largest, and the superlative accuracy of their transfer movements is plainly observable. When he

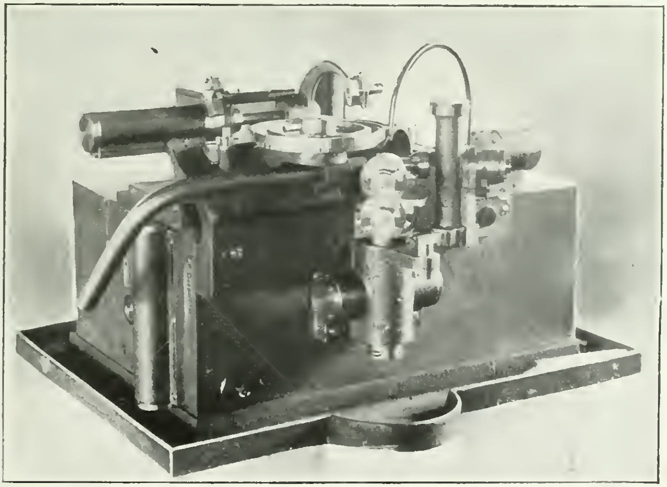


LEFT FRONT VIEW OF AUTOMATIC GRINDING MACHINE.
Showing actuating air cylinders in the body of the machine.

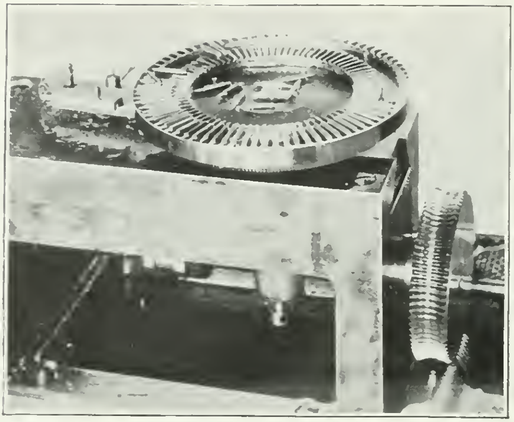


ENLARGED VIEW OF BALANCE STAFF AT SUCCESSIVE STAGES OF PRODUCTION.
The stages advance from the left. The figure on the extreme right is a sewing needle of the smallest size usually sold, affording a ready means of size comparison. Pivots can be made as small as 2½-1000 in. diameter. No back rest nor other support is used in staff turning. The cuts are made with white diamond tools. ground to proper cutting-edge form.

took the plate drilling in hand it was done through jigs handled by girls, each girl having a drilling machine with three vertical spindles carried in one head, each spindle rotating a different tool, and having an independent feed motion. Each girl drilled in a watch plate all the holes of the sizes produced by the three drill spindles of her machine;



DRILL-MAKING MACHINE. CAPACITY, 1,500–2,000 DRILLS A DAY.
Drills are made so cheaply by this machine that it is cheaper to replace than to sharpen a dulled drill. The drills are shaped from tempered-steel blanks, drawn to correct diameter by grinding, and are ready to use as they come from the machine.



AUTOMATIC DEAD-CENTER LATHE, SHOWING FEEDER PLATE.

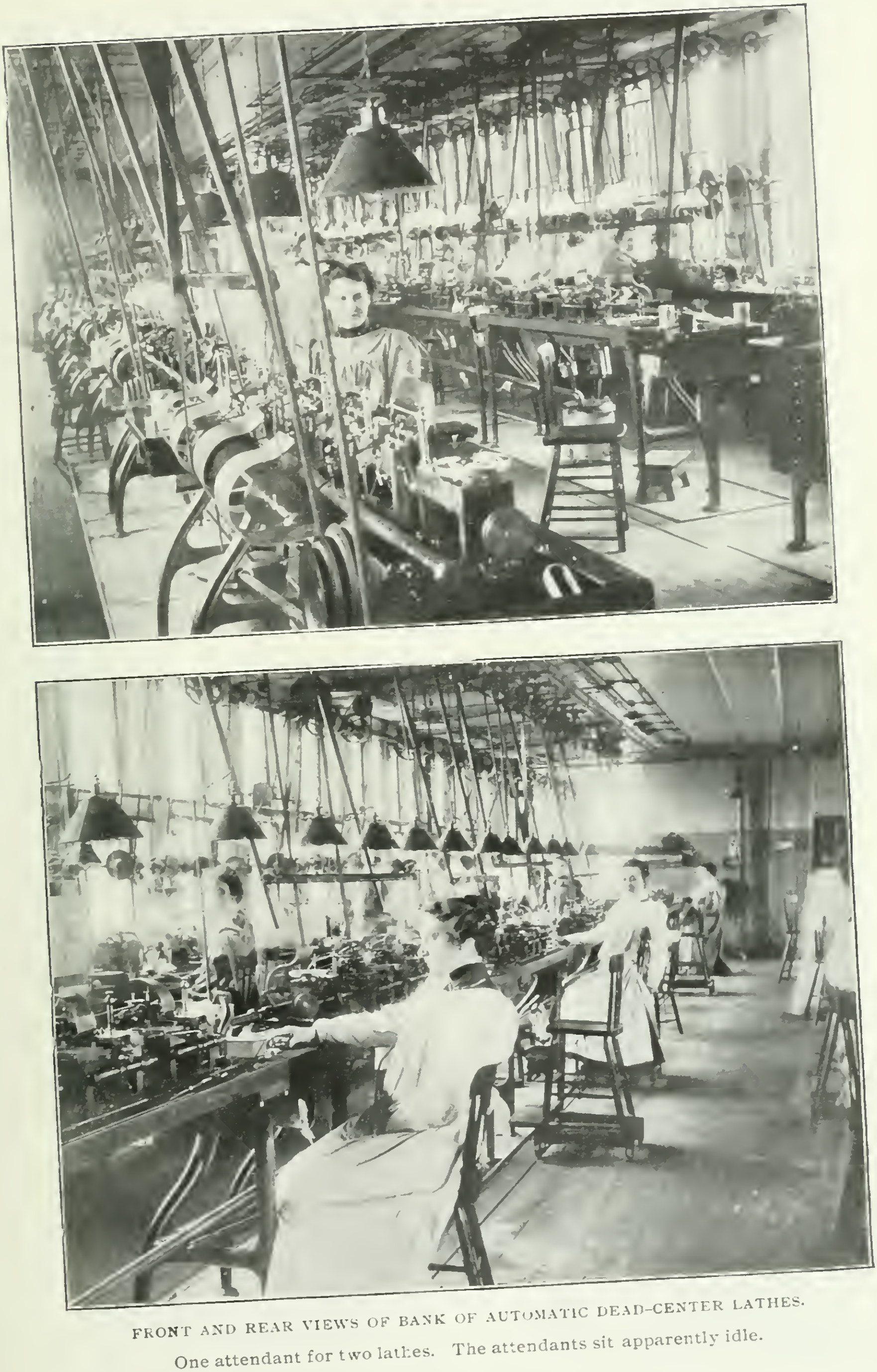
Except in the staking-machines, which are hand fed, all work is placed in the machines automatically, being fed from hand-filled magazines, tubes, or feeder plates, from which the machine takes one piece at a time to be operated upon.

then the plate was taken out of the jig and passed on to the next operator, who placed it in another jig and went on to drill the holes of the sizes produced on the machine under her charge. In spite of the utmost care possible, this step-by-step production produced imperfect plate drilling and made trouble without end.

Church had a clear conviction that there should be no jig work, which means that all holes must be located by the axis of rotation of the drill spindle, the drill itself having no surrounding exterior guiding surface, and hence that, for each hole, the plate must be brought to exact position in relation to the drill-spindle axis; if the plate could be held, say, horizontally over a rising drill spindle or cutter spindle, then the desired operation could be properly located in the plate. There are about one hundred and sixty different operations to be performed on a full plate; each vertical spindle head could conveniently carry as many as six spindles, and it was clearly possible to place as many heads, each carrying six tool spindles, as were needful, on one long frame, and provide

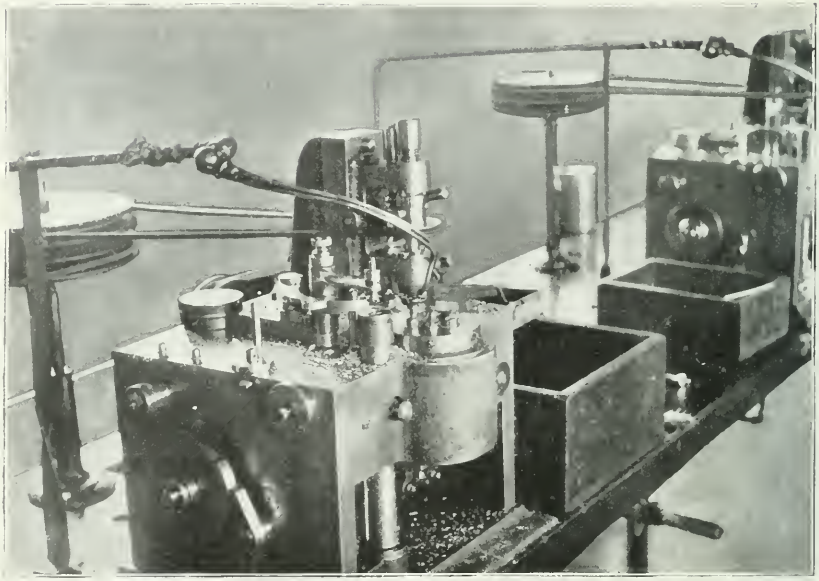
TESTING HARDENED WORK.

Truth of soft work is assured by methods of production. Hardened work is tested by being placed on double live centers and observed with a magnifying glass. The illustration is from a bank of five testing lathes, each operated by a girl inspector.



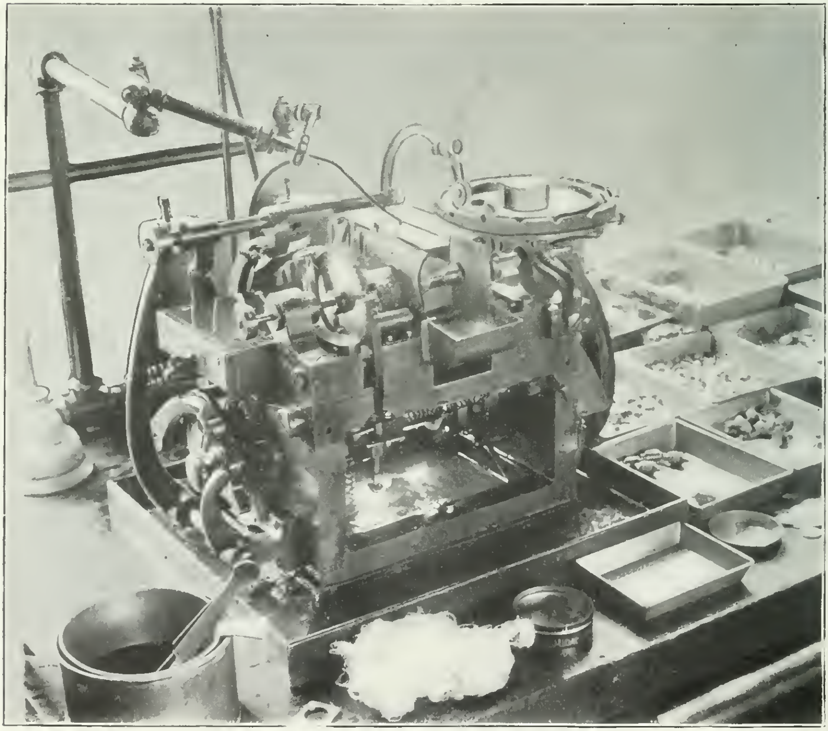
FRONT AND REAR VIEWS OF BANK OF AUTOMATIC DEAD-CENTER LATHES.

One attendant for two lathes. The attendants sit apparently idle.



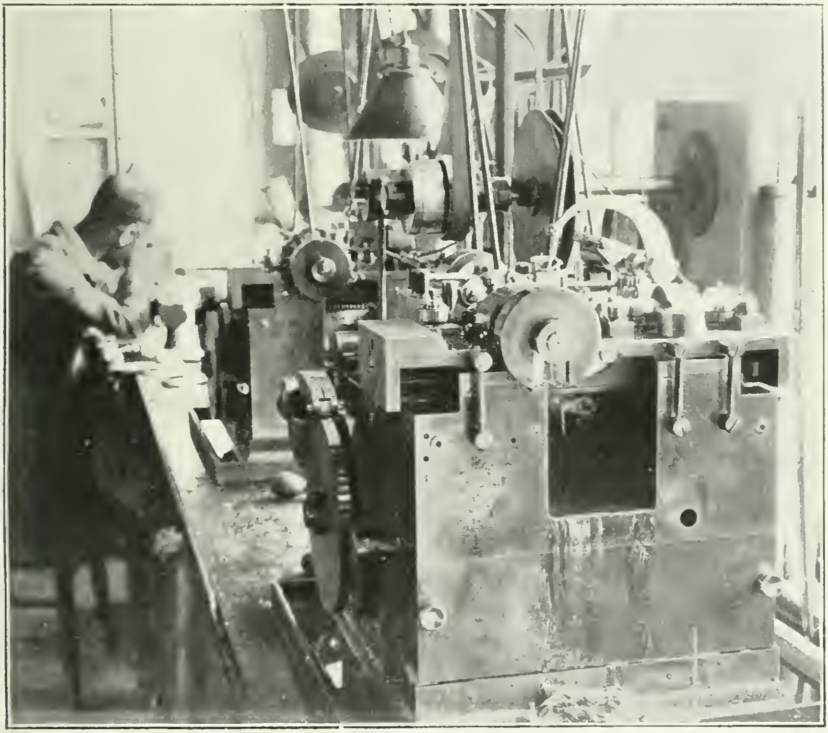
AUTOMATIC WHEEL-OPENING MACHINE.

For piercing the center of the wheel with a hole concentric with the teeth, after the teeth have been cut.



AUTOMATIC WHEEL-CUTTING MACHINE.

each of the six-spindle vertical heads with overhead plate holders, and to transfer the watch plates from one plate holder to another, successively, each plate holder correctly locating the plate over some spindle carried in one of the revolving spindle heads. It was also clearly possible to begin operations on the watch plates by supplying them in filled delivery magazines to the drilling machines, so that the transfer arm and hand could take a plate from the magazine and place it in the first horizontal plate holder, and from this first plate holder another transfer arm and hand could take the partly completed plate and deliver it to the next plate holder in sequence, until, at last, the final delivery arm and hand should place the completely drilled plate in a receiving machine, located at the end of the machine farthest from the delivery magazine through which the plates are given to the machine.



PINION-MAKING MACHINE. WHOLLY AUTOMATIC.

Wire feed The pinion is turned and has the teeth cut in it by successive operations before the machine releases the piece.

Here, then, was a clear, clean-cut, general scheme of plate drilling —which was, however, wholly impossible of construction with any

PNEUMATIC STAKING MACHINE. GREATEST PRESSURE USED IS ABOUT 3,300 LBS.

"Staking" is either a swaging or rivetting operation, by which two pieces are firmly united, and was formerly performed by a hand tool and hammer, and later by machines of the nature of a press. By both hand staking and press staking the polish is destroyed and has to be renewed, and the large flat wheel is "cockled," or distorted, by the setting up of strains in its thickness By the use of pneumatic staking machines, the pressure applied to effect the form-change can be so delicately graduated at the beginning of the operation that cockling does not occur, and the polish of the parts is not defaced.

details then known in tool-making. The horizontal plate holder could be mounted on two of Maudslay's slides, one carried by the other, and these slides could be so moved as to bring any point in the plate over the axis of the tool carrying spindle below—but how?

The answer Church made to this apparently unanswerable question was wonderfully simple and wonderfully suitable.

It was wholly impossible to produce the double motion of the plate carriers by means of cams and levers, for two reasons: first, want of possible accuracy, and, second, want of room. It was impossible to place the required number of cams and levers in their proper relation to the plate holders and spindles, and cams and levers being the only means known for operating automatic tool members, it was clearly impossible to construct this ideally perfect plate-drilling machine. The requirement was some device which would move two comparatively heavy slides, quickly and certainly, to positions absolutely certain with relation to a fixed point, which employed no mechanism, and was not subject to wear of any description. Could absurdity of mechanical demand go farther?

Yet these impossible conditions were met in the easiest manner possible by the use of compressed-air pistons and cylinders, applied directly to the moving parts, so that, whenever air pressure was admitted to a cylinder, the piston instantly drove the connected member to a flat contact stop of hardened steel, the rapidity of traverse and intensity of the contact blow being perfectly controlled by the air-admission cocks, which are cam-operated. With this beautifully simple and perfect machinery Church moves his plate-holding slides with positive accuracy, revolving heads of hard-steel stop pins giving each hole location in the plate an adjustable definition which can be individually regulated to any degree of precision desirable, with the practical result of producing watch plates with no measurable or discoverable variation in the location of the holes.

Here, then, we have the highest known development of the possibilities of the tool-maker's art, due to the addition, by Church, of compressed-air actuating devices to Maudslay's slides and Stone's turret.

The compressed-air movement makes accuracy possible, as it never before was. Compressed air gives movements with any degree of force, within any space limitations imposed by the exigencies of tool construction, and—impossibility of impossibilities—without wear.

The largest plate-drilling machines have a delivering and receiving magazine, six plate holders, six spindle heads carrying six spindles each, making thirty-six live spindles in all, and seven tranfer arms and hands.

Within certain size limits, this compressed-air actuation in combination with these transfer elements, which are capable of taking a piece of work of any form and accurately locating it in a workholder of any description, show the road to completely finishing any metal piece without direct manual intervention. That is to say, the methods and means now in operation at Waltham can be so modified as to produce any machine part without direct labor.

As to diameter-limit of work produced by this system, Church said that he thought his devices might be successfully and economically applied to pieces up to 10-in. or 12-in. diameter, and, in many forms of pieces, the length would be no bar to automatic finishing.

MERITS OF INDEPENDENT AND INDUSTRIAL TELEPHONE SYSTEMS.

By Kempster B. Miller.

A MORE complete monopoly than that enjoyed by the American Bell Telephone Company throughout its existence until the early part of the year 1893, probably never existed. This monopoly was based primarily on the fundamental patent of Alexander Graham Bell, covering broadly the art of transmitting speech by electricity, and secondarily on many hundreds of patents of greater or less importance covering apparatus and methods used in practical telephony. These later patents were the result of a wise and persistent policy on the part of the Bell company, and its manufacturing company, the Western Electric, to secure to themselves the right to manufacture and use all the inventions made by the engineers in their employ, and also to buy up all inventions of merit made by outsiders. So close-meshed was the web thus woven that it was thought that, even after the expiration of Bell's fundamental patent, the monopoly would still be maintained; for of what use would the broad art of telephony be to the general public if *all* of the apparatus and means for putting it into effect were still under the control of a single company?

With the expiration on March 7, 1893, of Bell's patent, which had been the subject of much litigation, and which, notwithstanding, had finally expired by virtue of having run its full term of seventeen years —numerous would-be competitors of the Bell company sprang into existence, and began their crusade with courage, in most cases born of absolute ignorance of the dangers ahead.

With the efforts of these early competitive companies, puny and of questionable character in many cases though they were, the present independent telephone movement in the United States began.

The outlook, at the start, was not encouraging. The Bell company controlled not only all the patents that were worth controlling, but practically all the men and consequently the knowledge. There was no practical literature on the subject, and telephone engineering,

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The closely local adaptations of the telephone—its uses in mine, factory and workshop—have, rather curiously, been among the latest to be developed. Mr. Miller has a most interesting theme in describing this side of the evolution, so insufficiently noticed heretofore.

unlike other branches of electrical engineering, was not taught in the colleges. The only school was that of practical experience in the Bell company—a good one to be sure, but of little advantage to the struggling independent companies at that time.

To-day, the conditions are entirely changed. Many strong patents have expired; weaker ones have been declared invalid by the courts; while others are in the estimation of the public so palpably weak that they are quietly ignored. The knowledge of telephone matters has grown with the demand for cheaper and better service. Good telephone men have been created from available raw material, and many old ones have abandoned the ranks in which they obtained their primary training for the apparently brighter prospects of the new field. With the increasing prosperity of the independent companies, the questionable methods of the early promoters have been largely eliminated and now there is a growing tendency, on the part of both manufacturers and users, to respect the rights of others and to wage the warfare on a basis more consistent with a movement of its dignity and importance.

As a result of the labors in the independent field there are to-day nearly three thousand five hundred independent telephone exchanges in the United States, and of these two thousand are within a radius of 500 miles of Chicago. The remainder are scattered in nearly equal proportions east, west, and south of that center, the numerical representation in the South being probably a little the largest. The seven States having the greatest number of exchanges are Illinois, with 287; Ohio, with 274; Iowa, with 251; Pennsylvania, with 242; New York, with 240; Indiana, with 236, and Missouri, with 202. The total number includes all sizes from the small village exchange connecting perhaps fifteen subscribers, to that of the Kinloch Telephone Company, of St. Louis, Mo., equipped with a switchboard of 8,800 lines—the largest in the world. In the whole independent field there are about 700,000 telephones in use.

Contrasted with these figures the number of Bell exchanges in the

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Beyond this, his review of the general telephone situation in the United States is most instructive because it displays the fundamental influences which have affected the progress of American telephone practice. These are vitally different from those prevailing in England and in the Continental countries where the telephone has formed a part of the postal system and has been under governmental administration. Electric-traction practice in the United States has made enormous advances, it is claimed, because it has developed under individual initiative and private management, without the proclaimed disadvantages of municipal or public ownership. It is interesting to follow, now, another branch of electrical engineering which has been peculiarly placed, resting to a great extent in monopolistic control, and to see how economic conditions have affected engineering practice in so typical an instance as is afforded by the telephone business in the United States.—The Editors.

United States is something over 2,100, while the number of Bell telephones is approximately 1,500,000; so that, although the independent companies have about once and two-thirds as many exchanges as the Bell company, the latter has over twice as many instruments.

In the matter of toll lines and long-distance service, the showing of the independent companies does not appear so favorably in comparison with the magnificent system of the American Telephone and Telegraph Company, controlled by the American Bell. The system of the American Telephone and Telegraph Company alone, embraces over 10,000 miles of pole lines carrying about 125,000 miles of wire. These lines cover territory in which live over one-half the population of the United States, and, in conjunction with the Bell exchanges at the numerous points reached, constitute a system not even approached elsewhere in the United States or in any other country.

While the independent companies have no system so extended, there are many sections of the United States covered by a closer network of inter-urban lines than that of the Bell company in the same district. Several movements are well under way for establishing a great artery of communication for independent work, extending north and south, east and west; and there can be no doubt but that in a few years this work will be successfully accomplished on a scale commensurate with the needs of the people.

The great problem among the independent people at present, and one which is receiving too little attention, is that of the standardization of apparatus, line construction, and methods of operation, with a view to subsequent co-operation with the long-distance systems. In telephony, as in football and other affairs, merit of individual parts, or men, is of little use unless all work together as a whole. Team work is needed. The lack of uniformity in the independent field is due, first, to a lack of concerted action between the various operators; second, to the many and faulty designs of apparatus furnished by manufacturers in the early days; and third, to ignorance, in many cases, on the part of the management of the operating companies. A perfect wreck of a telephone may be made to talk fairly well over short lines, and many such are forced into service. It takes a good telephone for long-distance work. The greatest difficulty, however, is not with the instruments themselves, for any of the reliable manufacturers are now making instruments capable of operating satisfactorily over very long lines, but with the lines and the lack of uniformity in methods of connecting them.

This question should be taken up with more vigor, so that local companies may build in such manner as to be benefited by the business over the long-distance lines of the present and future without the necessity of reconstructing their plants.

One of the most notable benefits arising from the new condition of affairs is the bringing of telephone service into small communities where the people could not hope to be reached by the large company. Co-operative companies have been organized in farming districts in the United States, each subscriber buying his own telephone and running his own line to some centrally-located farm house, where the switchboard—a small affair for perhaps twenty-five lines—is attended by the wife or daughter of the house for the moderate sum of fifty cents a month for each subscriber. The advantage, both industrial and social, of such a system to the farmer cannot be overestimated, the saving in long drives or walks over abominable country roads in winter being in itself enough to pay many times over the small outlay.

In the medium-sized towns the activity in the independent field has been greatest. Companies have been formed in nearly all such towns in which the Bell company operates, and in many not yet reached by it. The success of these has been marked. In spite of the poor apparatus, poor construction and poor management with which many of them were obliged to begin work, they have succeeded beyond expectations. Of course there are notable exceptions, but usually the failures have afforded horrible examples of how not to do things telephonic.

Not until recently has the patent situation or the engineering ability in the independent field made it possible to attempt successfully the building of very large exchanges. The expiration of certain fundamental patents has however opened up the field for large work, and the engineers in several notable cases have shown their ability to cope with the problem.

By offering lower rates and promising better service the competing companies, whether large or small, have almost invariably been able to secure nearly all the subscribers of the old company and many new ones, all bound by contracts running from three to five years. As for rates, the accompanying table shows, for several cities, the original controlling company's rates and those made by the independent company, and also the subsequent rate established to meet competition. It will be noticed from this that the combined rates of the new company and of the old after competition was started are, in nearly every case, approximately equal to the former rate of the Bell company alone.

TELEPHONE RATES, OLD AND NEW.

City.	Bell Company.		New Company.		Reduced Rates of Bell Co.
	Old Rates.	No Phones.	Rates	No. Phones.	
Detroit, Mich.	$72.00 and $50.00	5,000	$40.00 and $25.00	5.200	$36.00 and $24 00
Grand Rapids. Mich.	72.00 and 60.00	1,300	36.00 and 24.00	3,100	30.00 and 18 00
Trenton, N. J.	$60 00	400	36.00 and 24.00	800	26 00 and 24.00
Richmond, Va.	$60.00 and $40.00	1,160	36 00 and 24 00	1,350	30.00 and 18 00
Fayette. Ind.	48.00 and 36.00	400	20 00 and 18.00	800	18.00 and 12 00
Roanoke. Va.	48.00 and 30.00	......	30.00 and 20.00	400	18.00 and 12.00
Des Moines, Iowa.	72.00 and 60 00	735	24 00 and 18.00	1,200	36.00 and 12.00
Ft Wayne. Ind.	72 00 and 48.00	527	36.00 and 24.00	1,600	....
Toledo, Ohio.	$72 00	450	54.00 and 24 00	2,000	....
Elkhart, Ind.	$48.00 and $36.00	100	24 00 and 18.00	500	$36.00 and $24.00

It is frequently argued that the telephone is a natural monopoly, and that but one system can advantageously exist in a single community; but there is much to be said on the other side. In the first place, the service where a complete monopoly exists is likely to suffer. Corporations are not given to keeping their apparatus and methods thoroughly up to date merely for the sake of pleasing their customers, if they know they can keep them even with inferior service. Healthy competition in the telephone business, as in all others, brings about two desirable things, a reduction in cost and a betterment of service.

Aside from the improved service resulting from competition, there are other advantages due to two systems, which are often overlooked. The liability to tie-ups is greatly reduced. Many business houses will have telephones connected with both systems, and thus have two avenues of communication instead of one. The disability of one does not cut off the other. A still greater benefit, however, is the relief from the "busy" line annoyance.

The telephone is not of necessity a natural monopoly. Street car systems in a great city, or the railway systems in a great country, might be said to be natural monopolies in the same way. The system that takes a passenger rapidly and comfortably from any point to any other for a reasonable fare is the most desirable one. This might be done by a natural monopoly, but is usually accomplished by a system of transfers between the lines of one or several companies. Is the problem the same in telephony? At present no. In the future yes. The methods and apparatus of the independent companies are not as yet sufficiently standardized to make practicable a system of universal intercommunication. The courts have held, however, in more cases than one, that telephone companies are common carriers, and as the purely technical difficulties are removed there can be no doubt that the co-operation of exchanges operated by opposing companies will not only be possible, but will be demanded as a necessity.

That telephone systems of widely different characters can be successfully connected is proven daily by the connections over the long-distance lines of instruments operating in radically different ways. Blake instruments with local batteries and antiquated magneto calling apparatus are with impunity connected with modern instruments operating with common battery and other recent improvements. In the city of Chicago, nearly all kinds of systems known to man are expected to give service in connection with each other.

The question of private installations is of hardly less general interest and importance than that of public exchanges. The ability to buy telephones and accessories outright, instead of being forced to pay as annual rental a sum several times their actual value, has greatly enlarged the field of usefulness of the telephone. The connection one with another of the house and the barn or store, or of the rooms in the house, of the various departments of a factory, store, or business office, of the shafts and buildings of a mine, of several bases of operation in field or other engineering work—and, in fact, of the branches of any industry or pursuit—is thus rendered possible with a moderate initial outlay and slight expense for maintenance thereafter.

A brief description of the main features of a factory system will probably be of interest to the readers of this magazine in view of the recent excellent series of articles pertaining to shop practice. A factory telephone system—or, in fact, any interior system—may be installed on one of two general plans. The first of these is commonly called the "house" or "intercommunicating" system, and has the advantage of requiring no operator. In this, each telephone has an individual wire passing to all of the other instruments in the exchange. Besides the individual wires, one or sometimes two common wires also pass to each telephone. The wiring of this system, therefore, involves the running to every station of one or two more wires than there are stations, and the most convenient way of doing this is by means of a cable having the requisite number of wires, tapping to each wire in it at each station. Each telephone is provided with a simple switching device by means of which it can be switched from its own wire, with which it is normally connected, to the wire of the station desired. Conversation is always transmitted over the wire of the station that is called and one of the common return wires. Each station has facilities for obtaining, by itself, a connection with any other station.

The great disadvantage of this arrangement is that it is necessary, when through with a conversation, to switch the instrument back on its own line in order that it may be ready to *receive* a call from another station. Automatic devices have recently remedied this fault, but at the expense of greater complexity. The house system is not to be recommended except in small plants where an operator is not available. Where more than ten instruments are to be installed, the second plan should be followed; this involves the use of a central station, to which all lines converge, provided with a switchboard attended by an operator. In this there is the extra expense of the switchboard, but this will be compensated for in most cases by the smaller amount of line wire and the greater simplicity of the instruments. The expense of the operator is not so great as would at first appear, as in small exchanges some regular clerk can add this work to other duties.

The central-office system, if properly installed, is less liable to get out of order, is more easily repaired, and, on the whole, gives better service. Besides this, the fact that the operator is (or should be) a creature of intelligence, and not a machine, is a great advantage—especially in a factory. For instance: The superintendent calls for a connection with Mr. Jones, foreman of the screw-machine department. The operator finds he is not in his department, whereupon Mr. Superintendent may say, "Well, find out where he is and tell him to call me up immediately." This the operator may readily do, and with no further loss of time on the part of the superintendent. The operator in such a plant becomes a general information bureau, and as such, an exceedingly valuable adjunct to the shop.

As to the cost of private telephone plants: Good telephones may be purchased in the United States, complete with batteries, at a price ranging from $10 to $15 each; switchboards, from $3 to $5 a line, with perhaps $25 additional for cabinet and operator's equipment; and good rubber covered wire, No. 18 or 20 B. & S. gauge (19 or 21 B. W. G.) at about $6.50 per 1,000 ft.

The following itemized list shows the cost of a very complete interior system of twenty instruments actually installed less than a year ago. This was operated on the common-battery plan, doing away with all batteries at the various stations and centralizing all sources of energy. All instruments and apparatus were strictly first-class.

This plant was put in with a view to reducing future expenses to a minimum, and the cost represents a fair average for the best construction in this class of work. It is possible by using instruments less expensively finished, and where less wiring is required than in this case, to put in a first-class factory system for $20 an instrument, and in some cases for slightly less.

COST OF INTERIOR TELEPHONE EXCHANGE OF TWENTY STATIONS.

14 desk telephones complete, including granular transmitter and stand, bi-polar receiver and polarized bell, at $13.50......	$189.00
6 wall telephones complete, including same parts mounted on wall-board, at $12.00..	72.00
1 twenty-five-drop capacity switchboard, with hand generator, mounted on quartered oak desk, with twenty drops installed...	95.00
1 operator's telephone set, including transmitter and stand, receiver and head band....	10.50
11,500 feet No. 20 B. & S. gauge (No. 21 B. W. G.) rubber-covered wire, braided, at $6.50 per 1,000 ft....................	74.75
8 cells, storage battery, 16 amp. hrs., at $2.00.	16.00
10 cells Leclanché battery, at $0.45..........	4.50
Sundries, knife switches, screws, staples, nails, annunciator wire and lumber...........	5.25
Labor—two men 11 days, at $2.00..........	44.00
Total	$511.00

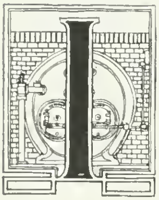
There is still another phase of independent telephony—the opportunities offered to young engineers. Telephone engineering is an important branch of electrical and mechanical engineering, and both the Bell and the independent companies offer opportunities not fully appreciated, I think. In the independent field there is a notable dearth of good men to take in hand the more important positions. The way to these is about the same as in other branches of the profession.

The opportunities at present are probably better in the independent than in the Bell companies, because the systems of the latter are already highly developed. In the independent field more remains to be done, for, while a few companies have developed their apparatus and systems to a high degree of perfection, the problems of truly long-distance service—connecting the independent exchanges into one vast system, and of arranging for transfers of connections between competing companies—are yet to be worked out. These and many other problems are interesting and elusive, and there are enough of them to keep many of us busy for years to come.

THE STEAM ENGINE FOR THE ELECTRIC-TRACTION POWER-HOUSE.

By Charles Arthur Hague.

II.--PROBLEMS OF DESIGN AND ERECTION OF LARGE STEAM UNITS.



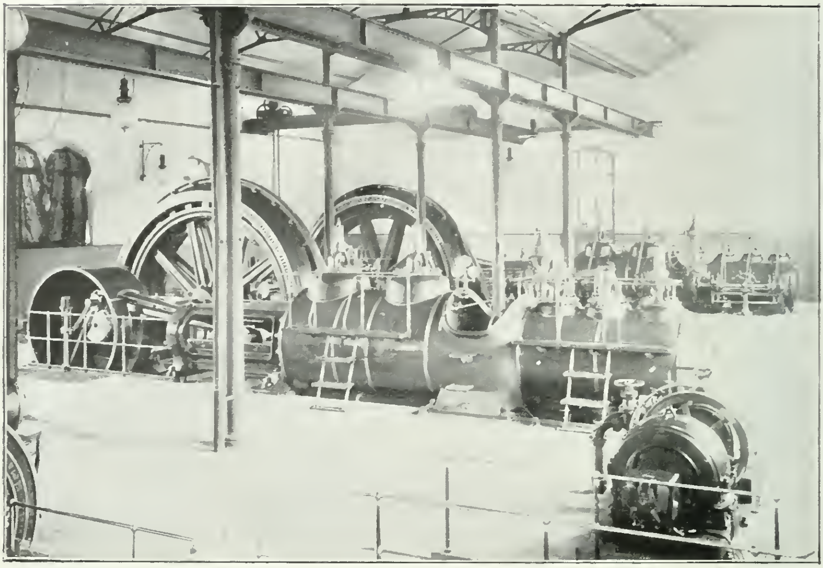
IN my former article, I considered generally the peculiarly difficult conditions imposed by the problem of the engine for the traction power-house, and the leading tendencies of the practice which has developed, in the United States particularly, in effecting a solution. It seems appropriate to supplement the abstract exposition by a concrete review of embodied practice, as exemplified in some of the largest installations of the day.

In referring more explicitly to the larger plants for generating electrical power it will be seen that the day for very large units is fairly with us, and it has come about that the capital and courage is at hand necessary for the combining of numerous small power stations into one, or into a few large ones. The three-phase alternating current at a high potential when the power is concentrated, realizes an economy in fixed charges, value of real estate, etc., that fully justifies the generating of a current of 5,000 to 10,000 volts, and sending it to substations at accessible points, there effecting a conversion of the alternating current, by means of appropriate transformers and converters, into direct current of moderate tension for use in the car motors. These large engine plants can be comfortably placed upon ground aggregating as low as four-tenths of a square foot per horse power, which, compared with one and a half to two square feet per horse power for small plants, will argue very strongly in favor of economy in labor and cost of real estate. In this age it does not seem to matter as to the quality of the ground chosen, as with liberal piling and capping with concrete, the most unpromising locality may apparently be made as the solid hills. An example of one of these large plants may be cited. It is to contain, when finished, eleven cross-compound vertical condensing engines, each having a direct-connected alternating-current generator upon its main shaft. The indicated power, under best economical load, is to be about 5,000 h. p., with capacity for overload going nearly up to 7,000 h. p. The generators are of the alternating-current class with the fields revolving and with outside armature; special provisions for accessibility to the various details of engines and dynamos are carefully and effectively thought-out in the designing of the machinery. The three-phase alternating-current will have a tension of 6,000 volts, which, in turn, will be changed to a 550-volt direct current at the points of use.

The condensing apparatus in these mammoth plants has not yet reached its height of perfection, and is no doubt a study by itself. Up to date the use of surface condensers with independent air and circulating pumps, seems to be the vogue, the condensed steam being mostly thrown away. Of course, in cities situated at salt-water ports, the feed water must be bought and paid for, in the absence of the return of the condensed steam from the surface condensers to the boilers. But the necessary amount of courage has not yet been apparent to return this water, with all its risks of cylinder oil, although a gross saving of from $50,000 to $80,000 per annum might be attained. A system of filtration and analysis of the feed water, in competent hands, would no doubt be possible enough, and its cost would yield a very large dividend as an investment, by the saving in cost of fresh water.

INTERIOR OF THE NEW 96TH STREET POWER STATION OF THE METROPOLITAN TRACTION CO., NEW YORK.

Showing two of the large Allis engines in place and the foundations of a third.



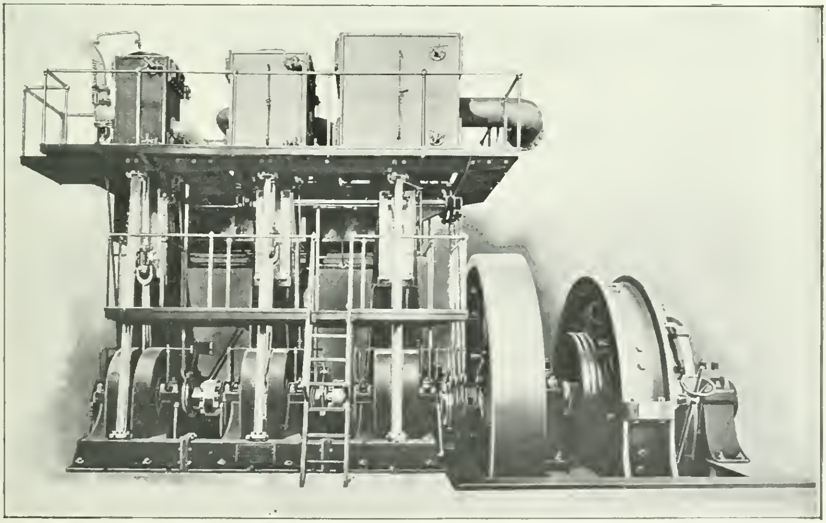
AN ELECTRIC GENERATING STATION IN ZÜRICH.

Two direct-connected sets of 1,000 h. p. each ; 100 rpm. Horizontal tandem-compound engines by Sulzer Bros.

The steam and exhaust-pipe systems are also food for study, and the possibilities of bold and effective treatment of these items upon such a large scale are admirably met. The steam is brought into the engine room, passed through a separator, and thence to the high-pressure cylinder ; the exhaust from the low-pressure is carried down to the basement, through feed-water heaters, and thence to the condenser. Provisions are also made for automatically exhausting into the atmosphere, in case of need ; and in some plants, arrangements are made in the design of the engines for sending live steam to the low-pressure cylinder and exhaust steam from the high-pressure to the condenser, thus cutting out either cylinder in case of necessity.

It may be of interest to some to note in what a short time radical changes have been made in engineering in this power-house practice. Less than ten years ago an investment, and a large one for the time, was made by a large company desiring electric power, in six horizontal triple-expansion engines with mammoth fly wheels belted to pulleys on counter shafts. The counter shafts, in turn, were belted to the generators, and were arranged with a system of friction clutches for desired manipulation. After about five years' use of the plant, aggregating 10,000 h. p., the progress made by the manufacture of electric machinery became so apparent that the company could not resist the evidence that it would pay to rebuild and re-arrange, and were rather astonished to find that each unit in the space used could just as well be 5,000 h. p. as of the 1,700 first designed. In making the changes, although some of the triples were saved and revamped, the new engines were put in of the cross-compound type.

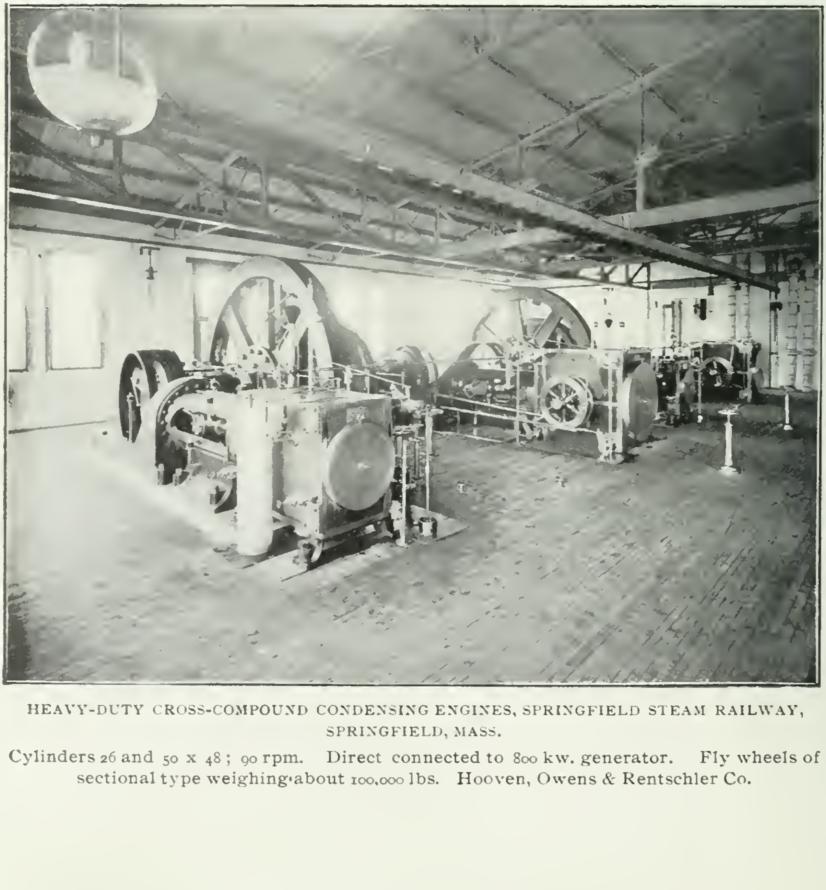
One of the largest horizontal condensing engines for electrical generation, if not the largest yet produced, and may be, the last one so large that ever will be built, will show somewhat the massiveness of modern engine construction. The possible horse power is 5,000 with 165 lbs. steam pressure; the engine is arranged as two tandem-compounds coupled into a four-cylinder cross-compound by means of a shaft common to both sides; the main shaft is of forged steel and made solid, 27-in. diameter at the generator field centre; main journals 24 in. diameter and 42 in. long; weight on the bearings, two in number, is nearly 150 tons; main bearings have water-jacketed shells; the cranks are of the disk pattern, each 8 ft. 4 in. diameter; crank pins 13 in. diameter and 11 in. long; cross-head pins 11½ x 11 in.; the cross-head shoe presents 722 sq. in. of bearing surface for wear; fly wheel weighs about 83 tons; the valves are gridiron slides, six valves for each cylinder, the cut-off controlled by a shaft governor; the pumps for the condensing apparatus are driven by electricity.



TRACTION POWER HOUSE INSTALLATION IN BUENOS AYRES.

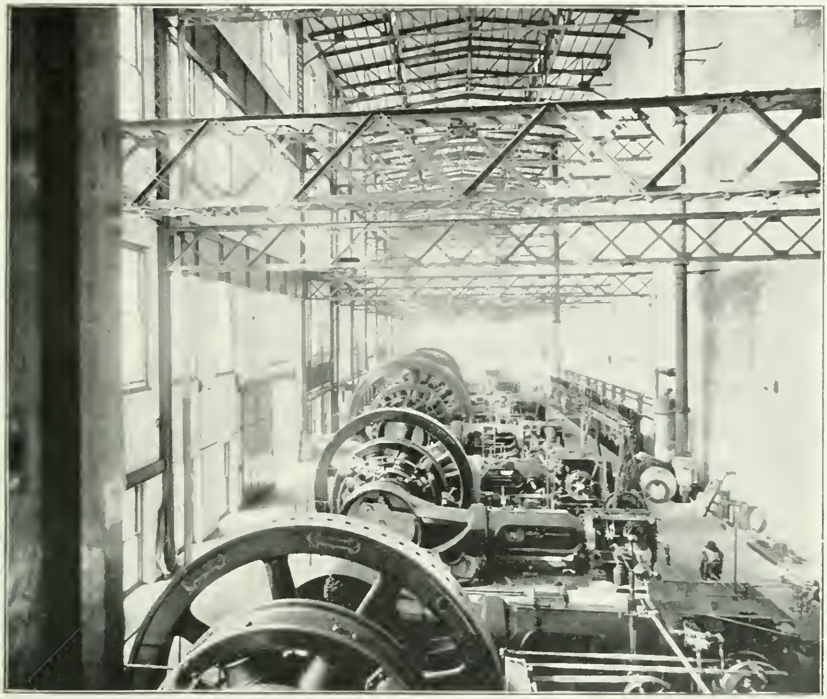
800 h. p. vertical triple-expansion engine with 525 kw. generator. Cylinders 14, 23, and 40 x 36; 125 rpm.

The various problems coming to the surface, in the matter of construction of the larger of the power-house engines, are extremely interesting as engineering considerations, and upon the successful settlement of some of them depends the question as to whether the engine of so large size and for so severe service can be constructed at all. The marine engine has gone as high in units as perhaps 15,000 h. p., but the variable loads to be taken care of strictly within the engine itself do not exist for the marine engine, nor does the continuous service under heavy stress begin to approach, in marine practice, the titanic demands found in the railway power-house. The regular line steamships have a continuous run of less than a week and then they have a week of inactivity. The famous Oregon, with all proud respect to her, made a continuous run of sixteen days as the longest without stopping. But, after all, the main point is that the steamship can be stopped without great hardship; the power-house engine, on the contrary, with the thousands of diversified interests at its mercy, can not



HEAVY-DUTY CROSS-COMPOUND CONDENSING ENGINES, SPRINGFIELD STEAM RAILWAY, SPRINGFIELD, MASS.

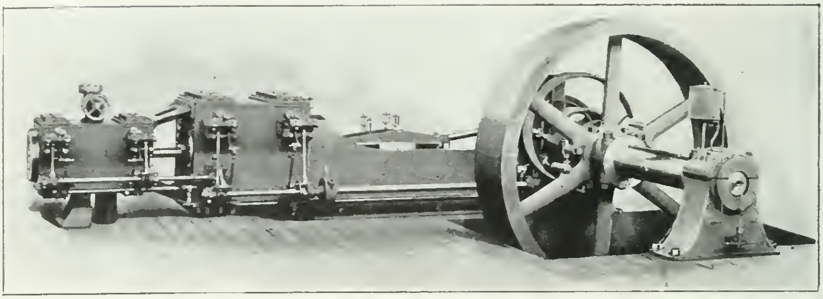
Cylinders 26 and 50 x 48; 90 rpm. Direct connected to 800 kw. generator. Fly wheels of sectional type weighing about 100,000 lbs. Hooven, Owens & Rentschler Co.



146TH STREET POWER HOUSE OF THE METROPOLITAN TRACTION CO., NEW YORK.

Three 1,200 h. p. and two 600 h. p. horizontal cross-compound Corliss engines.
The E. P Allis Co.

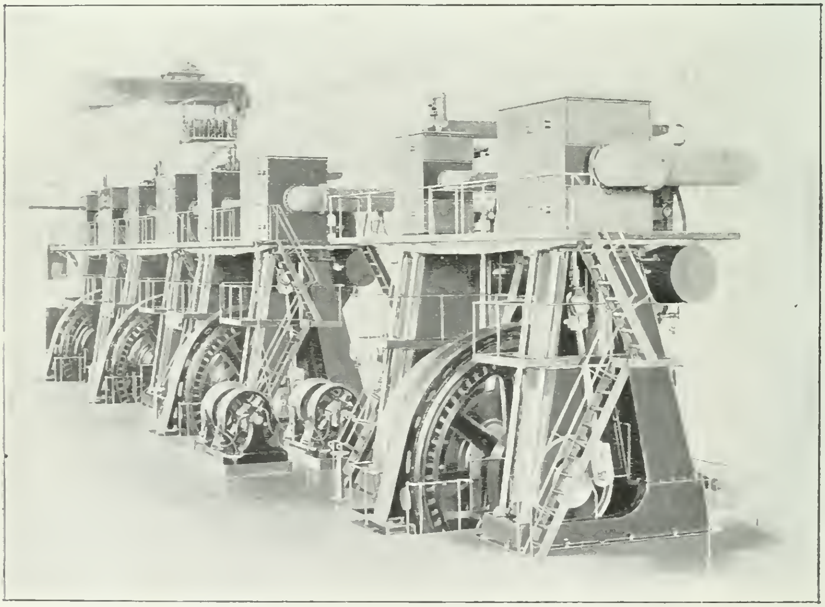
be brought to rest in many cases without results damaging beyond thought. The single item of crank shaft has grown to be something which nothing but gradually growing up to can make tolerable; in fact, the question of forging a crank shaft for engines of 5,000 h. p. and upwards is one upon which depends the production of these large units of railway power. The shaft forgings have a tensile strength of over 80,000 lbs., with 50,000 lbs. as the lowest limit of elasticity, and the material will lengthen some 25 per cent. before parting under test. Open-hearth furnaces carrying temperatures of 4,000° F. are employed in producing the size and quality of steel ingots from which such shafts are forged, and the forging is mostly accomplished by hydraulic pressure instead of by steam hammers, the pressure process permitting the flow and adjustment of the metal during the operation, instead of condensing the outer surfaces and leaving the centre spongy. Pressures as high as 14,000 tons are used in the work of hydraulic forging, the horse power of such work going up at times to



HORIZONTAL TANDEM-COMPOUND ENGINE, TRACTION POWER HOUSE AT CHELSEA, MASS.
Cylinders 14 and 26 x 30; 450 h. p.; 160 rpm. McIntosh & Seymour.

the enormous figure of 500,000,000 foot-pounds of energy per minute. The pressure at the pump sometimes exceeds 6,000 lbs. per sq. in.

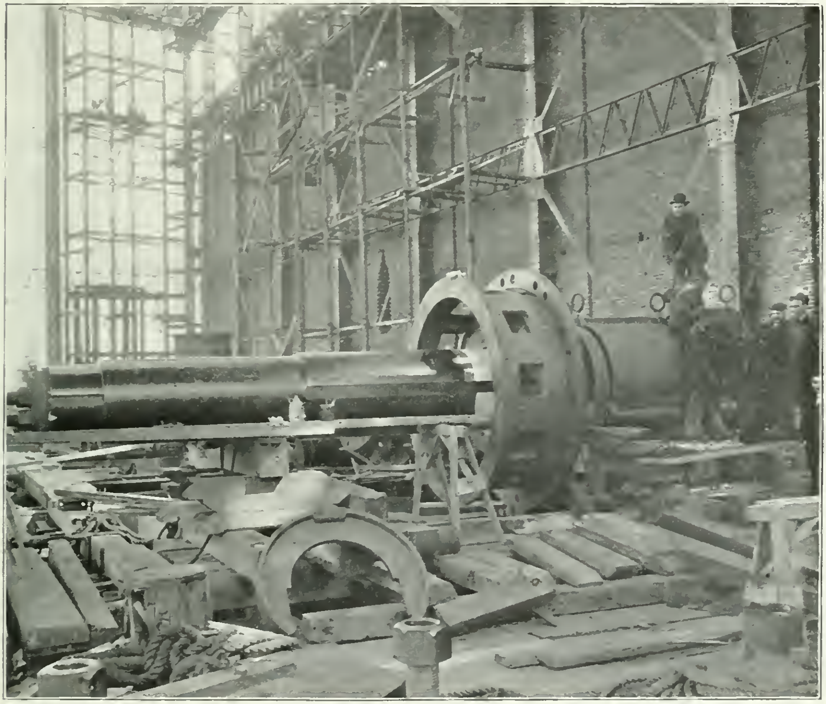
The object of the fluid compressed-steel ingots is of course to produce such ingots practically homogeneous throughout, or at least to confine the objectionable qualities to the centre of the piece where the defects may be removed by boring them out after cooling, thus leaving a sound, close-grained piece of material from which to forge a hollow



AN ELECTRIC GENERATING STATION, BOSTON, MASS.

2,500 h. p. vertical cross-compound engines direct connected to 1,500 kw. alternators. Cylinder dimensions. 28 and 58 x 48. 120 rpm. McIntosh & Seymour.

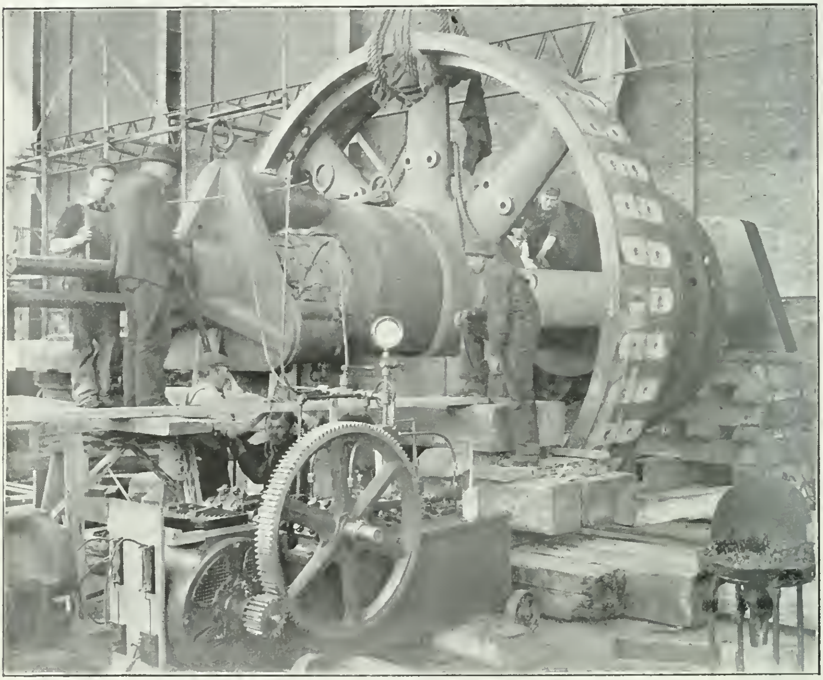
shaft; there are also incidental advantages in heating the cylindrical ingot not to be obtained with a solid. A steel mandrel nearly filling the hole in the ingot serves as an anvil, and the shaft is forged both inside and out, thoroughly compacting the material during the process. The forging is then annealed properly and oftentimes tempered in oil. Such shafts for power-house engines have been made of nickelized steel, fluid compressed, forged upon a mandrel by hydraulic pressure, annealed, and tempered in oil, having a diameter of 37 in. at the seat of the fly wheel, diameter of main journals 34 in., diameter of crank seats 30 in., diameter of hole through centre 16 in., length of shaft 27 ft., and weight, when finished, 76,000 lbs., elastic limit 35,000 lbs., and 25 per cent. elongation of material under test.



ERECTING A 5,000-H. P. ENGINE, METROPOLITAN TRACTION CO., NEW YORK.

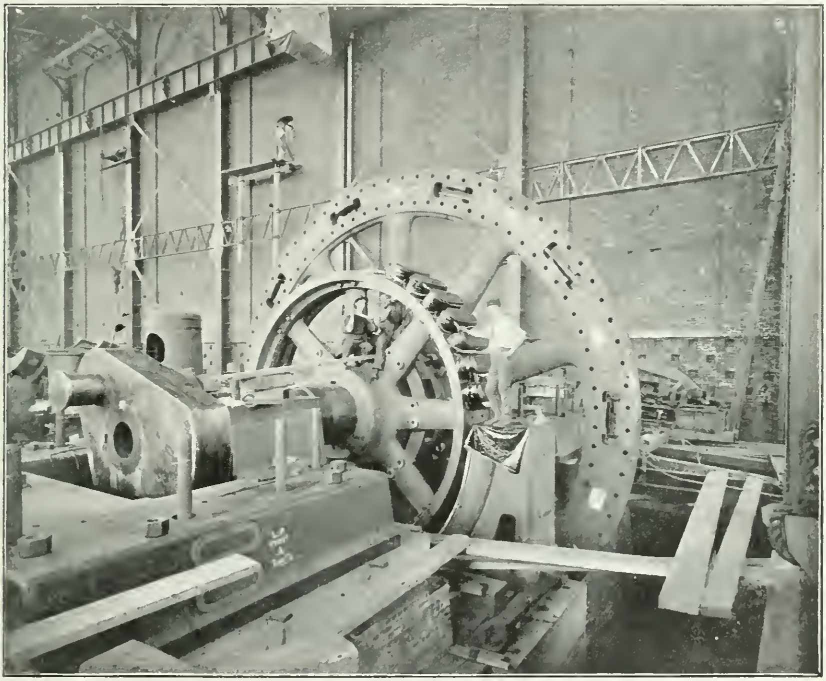
The shaft in position and fly-wheel center placed.

An engine with such a shaft would have a 42-in. high-pressure cylinder, a 92-in. low-pressure cylinder, a stroke of 60 in., and a speed of 75 revolutions per minute, steam-jacketed cylinders, piston rods 9 in. in diameter with a 3-in. hole through their centres and made of the same material as the shaft, connecting rods of the same material with 3½-in. hole through the centre, and having a neck diameter of 9½ in. at the cross head and of 13 in. at the crank-pin end, cross-head pins 12-in. diameter, crank pins 15-in. diameter, with 4-in. hole through the former and with a 5-in. hole through the latter. The weight upon the main journals of such an engine, including the shaft, the cranks, the revolving field, and the fly wheel, would be about 260 tons.



PRESSING ON THE GENERATOR SPIDER OF A 5,000-H. P. ENGINE.
Electric-driven hydraulic presses in service in erecting the engines in the new power station of the Metropolitan Traction Co . New York.

The erecting of engines so huge away from a shop and with temporary facilities sometimes presents tasks of serious moment, especially when, in these days of severe competition, all items of cost and expenses must be carefully weighed and, in making up an estimate, all unnecessary handling of material must be avoided. In a recent case of the kind a rather novel but entirely successful method was employed in the use of hydraulic jacks applied through the medium of an electrical pressure pump, for forcing into place upon the shaft the wheel centre, the spider of the generator, and the cranks. The fluid employed was oil, under a pressure of a little less than 10,000 lbs. per square inch, requiring about 11 h. p. to do the work; the time required to do all of the forcing was only a few hours, when once the apparatus was ready for work; the shaft weighed 68,000 lbs., the 16-ft. diameter spider 35,000 lbs. and the cranks 25,000 lbs. each. The final assembling of the parts of the fly wheel, and the securing together of the same, by cold riveting under the pressure of a hydraulic-jack riveting apparatus capable of exerting a pressure of more than 450 tons, is another expedient brought about by the exigencies of the situation. This system of cast-iron hub, arms, and a central portion of rim, with plate-steel laminations secured to the outer surfaces of the sides of the rim, is beginning to be regular practice for the large, heavy wheels of these great high-powered engines—suggested, no doubt, by the danger of using cast iron alone, where strains of such magnitude occur in the attempted acceleration and retardation upon

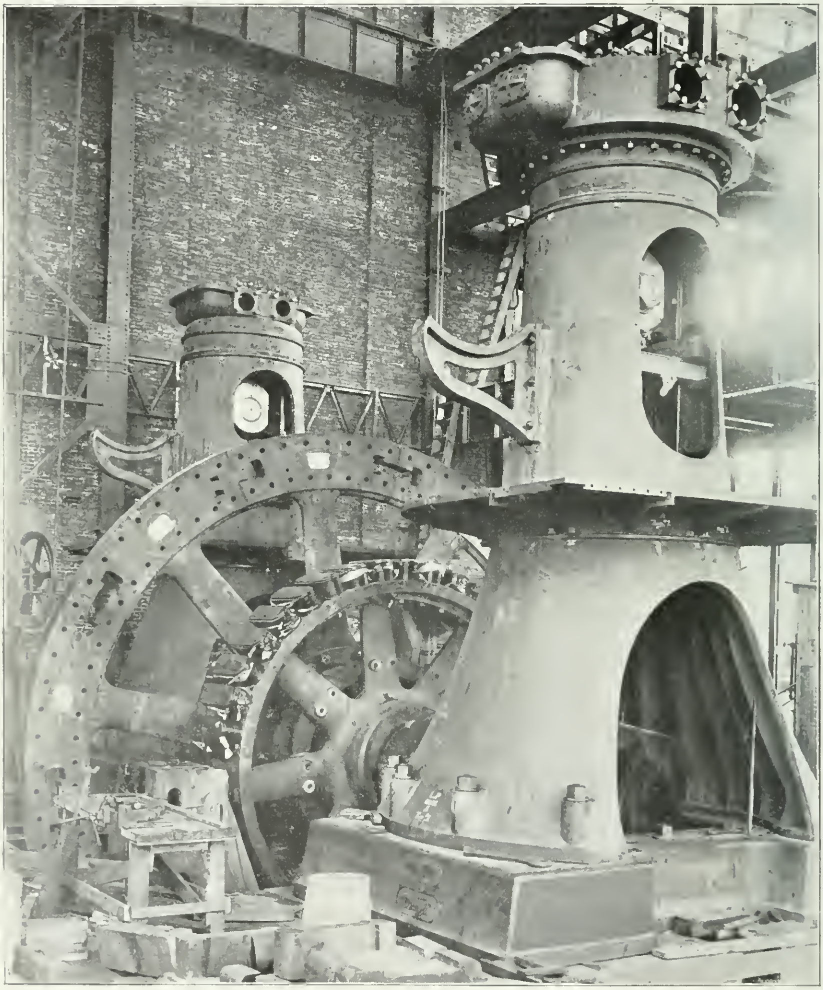


ERECTING A 5,000-H. P. ENGINE FOR THE TRACTION POWER HOUSE.

Showing the shaft in place, the fly-wheel built up, and work in progress on the electric generator.

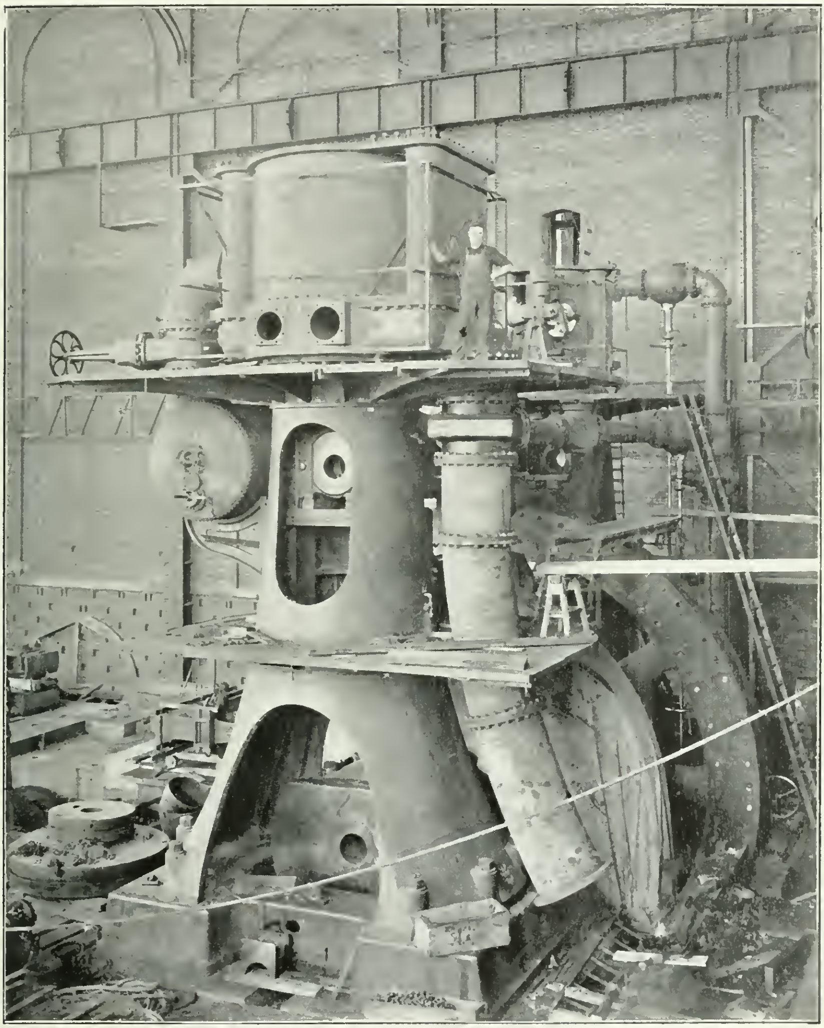
so enormous a scale. It can be imagined what this will be in a range of energy liable to extend from no load to fifty per cent. overload, to say nothing of some of the peculiar shocks to which an engine is liable in handling the electrical mode of energy.

The admission and distribution of the steam in these large engines, with the close regulation required, and with absolutely nothing but



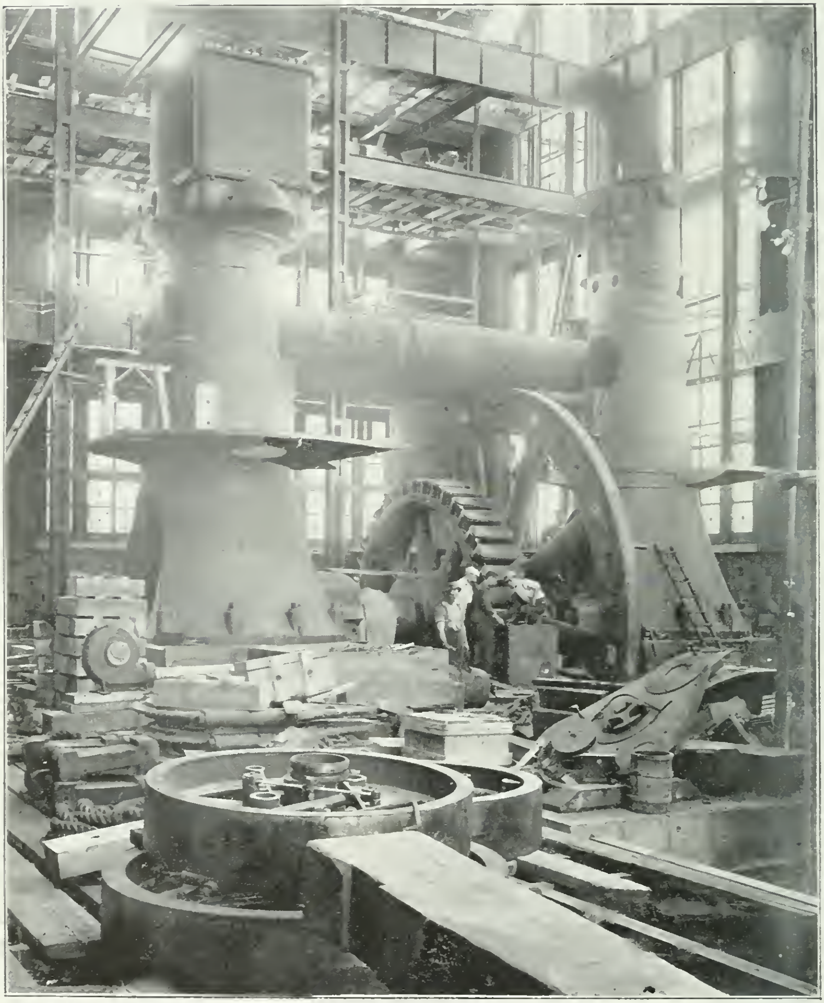
ERECTING A 5,000-H. P. ENGINE, METROPOLITAN TRACTION CO., NEW YORK.

Showing the arrangement of high and low-pressure cylinders on opposite sides of the fly wheel, and the manner of bolting together the fly-wheel and generator to relieve strains on the shaft.



A 5,000-H. P. VERTICAL CROSS-COMPOUND ENGINE, PARTLY ERECTED.
One of the large units in the new (Ninty-sixth Street) power house of the Metropolitan Traction Co., New York, approaching completion. The man standing on the upper platform affords an idea of the size.

the fly wheel to depend upon, makes the problem in this respect as difficult as any yet attempted by the steam engineer. The failure to grasp the idea that an electrical current of high voltage and great quantity is sadly lacking in inertia has been the cause of great and extended trouble. A cable plant expends about 40 per cent. of its



ERECTING A 5,000-H. P. STEAM ENGINE.

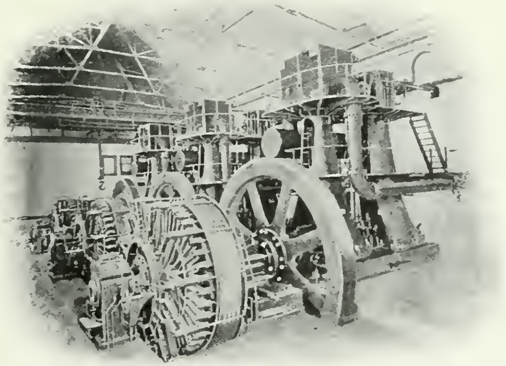
A single one of the 5,000-h. p. units in the new Ninety-sixth Street station of the Metropolitan Traction Co., N. Y., showing the main frame, shaft, fly-wheel, and generator erected.

power in maintaining motion in the cable, so that in addition to the fly-wheel there is the mass and resistance of the cable to steady the engine. With a steamship in motion the entire ship is fly-wheel and steadiment combined, and hence some of the valve details successful in marine practice completely fail when applied to a power-house engine on shore with nothing but some tons of wheel to depend upon and exposed to the erratic actions of an intangible phase of energy; a mode of motion so erratic, indeed, that in an unforseen second, if a fuse fails to blow, the direction may reverse and the generator be turned into a motor so suddenly as to jump the main shaft with all its ponderous attachments clear out of its bearings. The power-house engine is a unique production confined to the past dozen years or so.

Therefore, the induction and exhaust-valve mechanism, especially as regards the handling of the admission, cut-off, and release of the steam in this employment of steam power, is particularly exacting in its demands for adaptation to the duty to be performed. There are various kinds and types of valves for steam distribution, each having its intelligent and sincere advocates. The general field may be divided into two classes—one, in which the drop cut-off or releasing valve gear is used, and in which the regulator or governor simply indicates the point of cut-off without doing any of the work; the other, in which the so-called positive cut-off is used, and in which the regulator or governor holds and helps to drive the cut-off mechanism.

The mere statement of the two cases, it seems to the writer, points out the choice as to which is the better for power-station engines; and there is no mistaking the evidence of the times to the effect that the Corliss system so far is, and has been, the most extensively used and the most successful. With the valves across the cylinder heads, so as to reduce the clearance to a minimum, and with double eccentrics and arrangements for continuing the detachment of the cut-off hook beyond the ordinarily available point, it will doubtless be a long time before this system will be superseded in large and important engines for electric-railway power stations.

[For the illustrations of the power stations of the Metropolitan Traction Co., New York, THE ENGINEERING MAGAZINE is indebted to the courtesy of Mr. M. G. Starrett, Chief Engineer.]



ACTUAL EXPERIENCE WITH THE PREMIUM PLAN.

By H. M. Norris.

DURING the fifteen years that have elapsed since its invention, the premium plan has been adopted by a number of leading establishments, in but two of which has it failed to prove a success. In the first instance it was withdrawn by the management on account of the excessive earnings of the men; in the second it was refused by the employees for reasons presumably interesting enough to record. This was in the early part of 1899, when an attempt was made to introduce the system into the works of The Bickford Drill & Tool Company, Cincinnati, Ohio.

The workmen were almost all union men, opposed to piece work. The difference must be made clear to them. Explanatory notices, posted in the shop, might create a wrong impression and lead the men *en masse* to reject the plan. Apprentices, through expectation of benefit, and a portion of the men, through fear of discharge, might accept it, but these were not the best elements to win at first. The probable "kickers" should be won at the outset. The second perplexity was as to the tickets—how they should be worded and used, to avoid causing alarm by the "time limit," and to make clear the distinction between "time" per piece and "cents" per piece. A verbal explanation, instead of any ticket, seemed most promising. Next came fixing of the premium rates. Mr. Halsey's policy—liberality with time limit rather than with premium rate, would make it necessary, in many cases, to fix the time limit considerably higher than that consumed at present, in order that the men might not become discouraged by the smallness of their earnings, the time having already been reduced very near to its minimum. This would not do. It would be equivalent to raising the men's wages without the assurance of a corresponding gain to the employers. They would receive a bonus even though they did not increase their output. The shop could gain nothing except by an increase in the work produced. The gain to the works and the workmen should begin together. This involved the necessity of paying a higher premium rate. I decided to divide wages with the men. Having thus decided upon my course, I began making a card index of comparative statistics, showing the time consumed in the past on each operation of our standard line of production.

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* Speaker Reed is said to have defined the difference between theory and practice somewhat thus: "Theory takes account of all the conditions that can be discovered and calculated; practice deals with all the conditions there are." Mr. Norris has dealt with the labor problem on the hard ground of practice. His experience is therefore of the highest value to managers who are facing, or soon may meet, similar conditions.—THE EDITORS.

When the indexing had progressed sufficiently to enable me to commence operations, I went to one of our oldest men, spoke with approval of his time on a recent lot of sleeves (16 hrs. 43 min.) and told him the shop would, of course, be glad of any possible further reduction of time, and at the same time would like to see him share in the advantage. I proposed, therefore, to split his wages on every hour he could save under 17 hours. His answer—that it would suit him all right but he wanted no piece work—gave me an opportunity to explain to him that it was not piece work but the premium plan, aiming at division of savings and unification of interests; in any case, it was not compulsory and could be dropped at any time.

The man looked skeptical, and as though he were but half convinced. Still he tried it, with the result shown in the ticket below.

PREMIUM TICKET, SHOWING EARNINGS OF

Mr. *John Smith* No. 52 Tool No. 214

On *Turning, Boring and Facing*

6 Pieces. Marked 11 A 3 For Piece Order No. 5215

TIME	HRS.	DATE		REMARKS
Commenced	10	7—24—99		
Finished	10.30	8—3—99		
Time Limit	102	RATE	EARNINGS	
Actual Time	88½	28	24 78	
Premium	13½	14	1 89	
Labor Cost of Work			26.67	
Labor Cost per Piece				
Inspected				
By			Foreman	Read Notice on Reverse Side.

I then approached a number of the others, and in course of time had most of our leading hands working under it. Thus encouraged, I brought out the ticket shown above, the back of which read:

NOTICE.

"It is the purpose of the management of this Company to compensate its employees according to their individual ability to turn out good work at minimum cost, and in order that this may be done by a system that will not, in any way, endanger the present scale of wages, it has been decided to adopt the premium plan. Under this system each workman is assured his regular 'going rate,' whilst being afforded an opportunity of earning a substantial bonus on all work which he completes within the specified time set by the office. Tables have been prepared showing the average time consumed in the past in the performance of each operation on the several parts of our standard machines. These averages will be regarded as representing the minimum time within which the work must be completed in order to entitle the workman to a premium. It will not be difficult, therefore, for everyone to add something to his earnings, the amount of increase depending solely upon the individual effort of the workman. There is no risk of loss, but every opportunity for gain. A time limit once fixed will not be changed, except through the introduction of new methods of doing the work, so there need be no fear of earning too much money. Those who earn the most will be worth the most.

This slip shows on the reverse side the amount earned by you on the work indicated in the heading. The rates per hour at which premiums are figured vary according to the going rates of the workman, a schedule of which is given below.

Rates.	Prem.	Rates.	Prem.	Rates.	Prem.
5 — 11 =	5	16 — 17 =	8	22 — 23 =	11
12 — 13 =	6	18 — 19 =	9	24 — 25 =	12
14 — 15 =	7	20 — 21 =	10	26 – 27 =	13

"The conditions governing the payment of premiums are as follows:

"Premiums will not be paid on any work that is not completed to the entire satisfaction of the foreman

"Every workman must assure himself before commencing a piece of work that it will finish to the required size, whether the work is to be completed by him or others.

"No allowance can be made for bad material or deficient workmanship in any previous part of the work unless the same is pointed out to, and indorsed by, the foreman as soon as discovered.

"This slip must be carefully preserved, both for your own reference, and in order that it may be returned to the office in good condition in case of your leaving our employ.

"All premiums will be paid on the first regular pay-day following the completion of the work upon which they were earned."

For a time everything went smoothly, but one day a man came with a claim that a mistake had been made in the time limit on some wall radial arms. Only 84 hours had been allowed, while he asserted that the job had previously taken 86 hours. He admitted that he had made $1.40, but thought he should have made more, and remained unconvinced and unsatisfied, even after reference to the index showed the recorded times to be 86¾ and 82½ hours. His position was that the man who saved an hour should be paid for the entire hour—piece work was better than the premium plan, but he did not want either of them, and would sooner go on as he had been doing before the innovation. I assured him he need not take the extra money—there was nothing compulsory in it.

This was the beginning of the trouble. Time commenced to go up. Instead of coming within the old records, it ran above them. The men were "soldiering." I spoke to the foreman. He said he had noticed it, and asked what I thought had better be done. I told him we would have to make an example of one of the men, but must wait until we were sure of premeditated action. Time continued rising. Something had to be done at once. We had notified each of the delinquents a number of times without avail.

"Pick out the slowest, and one you can spare best, and let him off on Saturday," were my instructions to the foreman.

On entering the works the following Monday, I noticed a number of men at the wash troughs. Upon enquiring the cause, the foreman told me that one of the men had quit out of sympathy for the discharged employee and that the others had followed right along after him. This was all he knew about it. He doubted if half of them knew themselves why they were leaving. Five or six others started to go out, but returned, saying they wanted to know what they were going out for before they threw up their jobs.

I then sent for one of our oldest men—oldest in point of service—and asked him if he could tell me why the men had gone out so unceremoniously. He said the men did not like to work by the premium plan, that they were all doing the best they could for the company, and that it hurt them to see their old shop-mate discharged.

I told him that it hurt me, also, to discharge an old hand, but that, under the circumstances, there seemed nothing else to be done. "I notified him," I said, "a number of times that he was falling behind in his work, and had he had a legitimate reason, he could have spoken to the foreman, who is always willing to make a liberal allowance for hard castings or other causes of delay beyond the workman's control. If he had run behind on but one or two jobs, we would have thought nothing of it, but it became chronic. Work that he used to do in 16 hours before the introduction of the premium plan lately took him 24 hours, and it looks to us very much as if he had agreed with some others working near him to keep his time as high as possible in order to defeat the object of the new system."

He did not think this could be true, being unwilling, from his knowledge of his fellow workman, to believe he would be a party to any such arrangement. He suggested, as causes for the increase in time, a run of hard castings, delay in waiting for the cranes, or possibly illness. I suggested that, in any such case, the man needed only to come to me and he would be sure of consideration.

I then dismissed him and sent for another man, who very promptly expressed his surprise that Blank had been retained by the company as long as he had. "The union," he said, "forbids its members working under either the piece-work or premium system, and here lies all the trouble. There is no question but that the premium plan is all right, but you can't get them to see the difference between it and piece work. I understand that they have resolved upon making a general strike in all shops using either of these systems, not only in Cincinnati, but throughout the country."

Later in the day I left word at the general office that I would like to see two of the men when they came that evening for their money. When they appeared at my office I asked if I should expect to find them in their places in the morning. One of them answered that he did not think he would be back, but the others would do as they chose. The trouble, he said, in answer to my questions, was their belief that the system under which their fellow had lost his job would prove equally bad for them. He was a good man, an old hand, and should have more consideration. I pointed out the moderation of our course, our slowness in acting even under long provocation, our regret at having to dismiss the man, and our sincere desire to do justice, to make the work agreeable, and to grant all reasonable requests, citing recent instances. I offered any desired explanation of the premium plan, and assured them again it was in no way obligatory. The spokesman replied that he understood some of the men boasted of having made a good thing out of it, but none of them liked it. If they suddenly cut down their time, I would think they had been loafing all the past years and would want them discharged. The minute a man began cutting his time, it showed he had not been doing his duty in the past. Furthermore, it cast discredit on the foreman, who ought to know whether a man was doing the right thing or not. Time records were all right, but the foreman ought to decide these things.

I assured him the foreman did decide these things, but that was a side issue. The discharged man would not be reinstated. Before making his discharge a cause for leaving, however, I thought they had better think it over.

Next morning they returned to state the conditions under which a strike could be avoided. They were the reinstatement of the discharged man, and of all who had gone out in sympathy, and the abolishment of the premium plan. To my reply that this was impossible, they responded that there was no more to be said. They had given their message and would return with my answer.

"My answer is this: If the strikers wish to return to their places, and do so at once, they may; if the men do not wish to accept the additional compensation due them under the premium plan, they can leave it at the office, give it to the poor, or turn it over to the union, but Blank cannot come back. You may say, also, that the management of this company will always reserve the right to discharge any and all employees whom, in its judgment, it is better without. Further, that we shall, at all times, reward our employees for increasing production by any method we think best."

They said they would report my words and bring the men's decision in the morning. Matters looked grave. The conditions seemed to be either an unconditional surrender or submission to indefinite stoppage at a time when the shop was overcrowded with work and behind in its orders, many of which were accepted under penalty. There was little prospect of getting work done outside. Surrender, on the other hand, would forever destroy the discipline of the shop and place its management in the hands of the union. The action of the men seemed wholly causeless and unreasonable—they were certain to lose, but so were we. It seemed incredible the union could sustain them. But if the union forbade men working under the premium plan, I must either fill the shop with non-union men or withdraw the plan. Yet what was there to withdraw? Must we agree not to give money to any of the men against their wishes? With the idea of bringing home to the men a sense of the ridiculousness of the situation, I posted the following notice:

> "Since there seems to be some misapprehension in regard to the introduction of the premium plan of rewarding our workmen for their efforts toward increasing production, we wish to state that there is nothing compulsory about the system, and in order that this fact may be clearly understood we declare that
>
> THE PREMIUM PLAN IS HEREBY WITHDRAWN
>
> from all employees who do not desire it. No one shall be forced to accept any compensation beyond his regular wages. It will be be paid to those only who ask for it."

The next morning I received a call from the business agent of the International Association of Machinists, Cincinnati and vicinity—Mr.

Seifreat. He said he had called in the interest of the International Association of Machinists, to which nearly all of the men belonged, to talk the matter over in the hope that some agreement might be arrived at whereby the difficulty might be adjusted amicably.

"Very well," I replied, "if the men now working in this shop have appointed you their representative, I shall be glad to talk with you. What complaint have they to make?"

"They seem to feel pretty sore over the-discharge of one of your old hands which, I am informed, was brought about by the introduction of the premium plan. They claim that he was one of the most industrious workmen you had, and that you had probably made some mistake in fixing the time limit on his work. Do you not think that this is quite possible?"

"It mght be possible on one or two jobs, but not on all his work. Our records are kept too carefully to permit of many errors, as you will see from an examination of our methods, which I shall be glad to show you."

I then explained our system in detail, showing how the time limits were fixed, not from the time made by the most rapid workmen, but from the average time made by all. "Limits cannot, however, be fixed by rule of thumb," I said. "In a repetition business, such as ours, the same work is frequently done by one man a large number of times. Here is a card containing a record of the time consumed in boring and turning each of the last six lots of No. 0 mitres. The time runs: 144, 76, 60, 38, 27, and 25 hours respectively. This work has not yet come under the premium plan, but you will note that I have allowed 30 hours—the mean of the last three figures, each of which was made by the same man. He knows he can do the work in 25 hours, and that the other 5 hours is all clear gain to him. What could be fairer? In this case the risk is ours, not his. If he does not beat his last time, we will lose five times the half of his wages. You will see that the trouble does not rest with us. We are always anxious to retain the services of our old experienced hands, and discharge none without good and sufficient cause. We have but a limited number of heavy tools, which makes it necessary to work each to its fullest capacity. Most of our men are cutting their time daily, while the time of the man in whom you appear so interested shows a daily growth."

"Possibly the knowledge that he had to get the work out within a specified time made him more or less nervous. Could not this have had something to do with it?"

"Yes, and that is one reason he was not discharged a month ago."

"But can you not give him another trial? He has been with the company so long that I think he is entitled to special consideration. Put him on a different machine, and then, if he prove unworthy, let him go. This will settle the difficulty—now that you have abolished the premium plan—and the men will return in the morning."

"I have no objections to the return of the strikers, as I think they have already begun to realize the absurdity of their course; but the abolishment of the premium plan and the return of Mr. Blank are out of the question."

"Suppose I tell him to come down, say, in a day or two, and——"

At this, however, I became impatient and closed the interview, telling Mr. Seifreat that the men were acting foolishly and he was in the wrong in upholding them. If a strike was to be ordered, we would fight it; meantime I bade him good day. An hour or two later he returned, bringing the discharged man and one of the strikers.

"After leaving you this morning," he said, "I met Mr. Blank and told him what you had said about falling behind in his work. He says he has never done a full lot before of some of the work called for by the tickets you showed me, and does not see, therefore, how you can regard his time as excessive."

"Mr. Blank's memory is very short," I replied. "He has done each of these jobs several times, as the job tickets will readily verify. Let us look at them." With this I produced a number of time cards. "Here," I continued, "is the record of his last job. You will note that he took 55¼ hours to do that which he did the time before in 49½ hours, and the time before that in 46 hours."

Blank endeavored to use the excuse of "hard castings," even against a malleable-iron job, and to my offer to go further into the cards, if enough cause for our action had not already been shown, Mr. Seifreat advanced further efforts to have the man given another trial. I told him my answer was final—we would fight a strike, if needed, but would not recall our action in discharging the man.

This ended the strike. The men were all at work next day—that is to say: they were all there except Blank and one other whom I had said we did not care to have back. For five days nothing was said by either side. Then came pay-day. I went to a number of the men and said: "There's a premium due you from last week; would you like it enclosed in your envelope?"

"No, sir," came the very prompt answer from each.

I was nonplussed, chagrined, embarrassed—almost disheartened. I felt that it was of no use to wrestle with them longer—that it would be impossible to overcome their prejudice—that I must abandon the effort. The age of miracles had passed. The blind could not be made to see. The premium plan had received a heavy blow. Its recovery seemed doubtful. Still I hoped.

Another week passed. In the meantime I communicated with Mr. Halsey. He advised that I get the men together, explain the object of the premium plan—using as a text the increased earnings shown in an article he had just published,* and then propose that they agree to work under it earnestly and honestly for a year—that is, give it a fair trial for that length of time. We, on our part, to agree to submit the matter to them for vote at the termination of this period, and to abide by any decision they might reach regarding its further use. I thought the suggestion a good one, and resolved to act upon it.

Meantime I talked the matter over thoroughly with one of the brightest and most influential workmen in the shop—an Englishman of many years' experience and much more than average intelligence. His attitude, put into a single paragraph, was this:

"I don't see anything wrong with the principle of the plan, but the men won't have it. They think it the entering wedge to piece work, and if you argue from now till doomsday, you'll not be able to convince them otherwise. To accept it on trial for a year with the privilege of doing away with it at the end of that time, is not feasible for the reason that although they might wish to drop it they would not dare to for fear that you would insist upon their maintaining the same break-neck speed they had attained while working for the premiums. You have asked me to speak to you as man to man, and I do so. There will be trouble the moment you attempt to press the matter. Of this I am positive. But if you can convince our general manager, and he says: 'Boys, it's all right,' everything will go smoothly."

There seemed no alternative. I must either treat with the officers of the union direct, or give up the attempt to introduce the system. I chose the former, and wrote Mr. Seifreat as follows: "Will you be kind enough to furnish me a copy of the by-laws of the International Association of Machinists, also a statement setting forth the objections held by that association to the premium plan of paying for labor, invented by Mr. F. A. Halsey, of New York?" The reply read:

"As I am not familiar with Mr. Halsey's premium system I cannot give the objections this association may have to it, but believe that sections 1 and 3 of article 22 of our constitution would prohibit any

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*Experience With the Premium Plan of Paying for Labor, *American Machinist*, Vol. 22, No. 10.

member from accepting work under it, as it comes under the head of piece work." This confirmed my suspicion that the fight was being made in ignorance of the very subject in dispute. However, I turned to the sections cited and found them as follows:

> "Sec. 1. Members introducing any person or persons other than machinists, machinists' apprentices and others as specified in Sec. 2, Art. I, into the trade and assisting them shall be heavily fined for the first offense and expelled for the second."
>
> "Sec. 2. Any members introducing or accepting piece-work, or running two machines in any shop where it does not exist, shall be subject to expulsion."
>
> "Sec. 3. On and after May 1, 1898, all members of the International Association of Machinists shall refuse to work by the piece or run two machines. This shall also apply to those engaged under the piece-work system."

Seeing nothing prohibitory to the premium plan in that, I asked Mr. Seifreat to call and take the matter up in person.

He came and listened attentively to all I had to say. I read him Mr. Halsey's letters, showed him his paper, referred to his article, spoke of the objections to the day's-work plan, pointed out the bad features of the piece-work plan, called attention to the weak points of the gain-sharing and differential-rate system. I explained the workings of the premium plan—talked, in fact, until I had exhausted every argument on the calendar. But it made no impression. He persisted in confounding the premium plan with that of piece-work and other systems, classing together and pronouncing as bad all methods tending towards increasing a workman's output. He declared them to be simply a scheme of the employer to augment his bank account at the ultimate expense of the workingman. He said he believed all such systems worked injury to both the employee and the employer—to the former, by engendering a feeling of rivalry and discord among the men, and to the latter, by compelling him to accept inferior work.

"It is the transient workman only," he said, "who derives any benefit from them. He comes into a shop, pushes through an abnormal amount of work, gets his stake, and pulls out, leaving his output to be reworked at the expense of the company. This record is then taken as a standard of efficiency. The old hands must either slight their work in the same manner, in order to avoid falling behind the dishonest man's time, or look for other jobs. I have been with a good many firms and have never known it to work otherwise."

"Your argument may be more or less true of piece work," I answered, "but not of the premium plan. Under the former, the wage-cost per piece of merchandise remains the same no matter how great the increase in output of the workmen; hence, if the piece prices are fixed too high, the manufacturer must either cut them or continue to pay extravagantly for his work. Instead of receiving a substantially equal division of the savings, he gets but little, practically all of it going to the workmen. Under the premium plan, half the saving in wages goes to the workman and half to the employer, rendering a cut unnecessary, even though the time limits should prove considerably higher than necessary. A time limit is never changed after being once fixed, and if you wish it, we will give you a written guarantee to that effect."

"If the time limits continue in force, the system might, perhaps, be a benefit; but systems are not devised except as a business move on the part of those in charge of a shop, and, in the end, the workmen are invariably the losers."

This interview was followed shortly by a call from Mr. James O'Connell, grand master International Association of Machinists, and third vice-president American Federation of Labor, who, after expressing regret at the men's action in striking before they had so much as stated their grievance to the company, argued the case as follows:

"The premium plan partakes of the nature of piece work and, like it, causes a constant straining to increase production, which, besides lowering the standard of workmanship in the shop in which it is employed, serves to develop the worst element of human nature—selfishness. I have devoted the best years of my life to the study of this problem, and have never known an instance where the introduction of any system other than the day's-work plan did not ultimately result in the men being charged with all breakage and spoiled work."

"That can readily be done under any system," I replied, "but it is not our purpose to cause the men to suffer such loss. We shall certainly pay no premiums on spoiled work, but, if a man runs behind on one job, he will not be obliged to make it up on the next, and in no case will he earn less than the current rate of wages. It rewards the strong without injuring the weak."

"Even so, labor derives no benefit. For example, let us suppose that your daily wages amount to $1,000 and that, through the use of the premium plan, your output is increased until this account becomes $1,250. The men gain an advance of 25 per cent., but the output of the shop, figured on the basis of an equal division of wages for time saved, is increased 50 per cent. This is more than you can dispose of. You lay off a part of your force, retaining only enough men to maintain the former output. The result is that you drop back to your original pay-roll of $1,000, which, instead of being distributed among five hundred men, goes into the pockets of the relative few. The rest remain idle, and labor, as a whole, loses."

"You are then opposed to everything that tends to minimize labor. In other words, you think mankind suffers through the invention of the locomotive because of the vast number of stage drivers, horse dealers, saddlers, and carriage makers who were thrown out of employment when overland coach travel was relegated to the past?"

"No, I believe in the minimization of labor, and hope to see the day when the week's work will be done by the pressure of a button."

"The two thoughts do not harmonize. But let us confine ourselves to the point in question. The premium plan undoubtedly stimulates production, and, if our competitors operate their shops under this system, we must either do likewise or submit to being undersold, with the inevitable result of losing trade. Wages must be reduced or production increased. We cannot pay a dollar for work obtained by our neighbor for seventy-five cents."

"We have no wish to injure trade. The union recognizes the fact that the manufacturer has some rights, and that there should be one law for all. We must either prohibit the use of all such systems, or devise some means of controlling them. This question will probably receive considerable attention at our approaching convention, and I would recommend that you allow the matter to rest until I am able to advise you of what action is taken. The men are not prepared to accept it at this time, and if you attempt to force it upon them, we shall be obliged to fight."

"To my mind, the sole trouble lies in the men's lack of confidence in their employer, to overcome which I have framed a proposition which, in point of fairness, must appeal to every intelligent workman. See if there is in it anything to which you would be unwilling to agree." I then handed him the proposition, which read:

> "Conditions under which the employees of The Bickford Drill & Tool Company agree to work faithfully and conscientiously under the premium plan of paying for labor.
>
> "1. That each employee shall be guaranteed his regular day's-work wages so long as he shall remain in the employ of The Bickford Drill & Tool Co.
>
> "2. That the time limits shall never be lower than the best time made with the same tools under the day's-work plan.
>
> "3. That no one shall be discharged because of failure to reduce his time below the limits.
>
> "4. That, in addition to his regular wages, each employee shall be paid one-half his regular hourly rate, less any fraction of a cent, for each and every hour he may reduce his time below the prescribed limits.

> "5. That a limit once fixed shall not be lowered, except through the introduction of new methods of doing the work.
>
> "6. That all premiums shall be paid within two weeks of the completion of the work upon which they were earned.
>
> "7. That at the end of one year's time the system will be withdrawn from all those not wishing to continue working under it.
>
> "8. That, if withdrawn, the employees shall not be required to work at the same rate of speed without an equivalent in wages."

"That seems fair enough," said Mr. O'Connell, "and if you have no objections I will take this with me and lay it before our general executive board." There was nothing more said worthy of record, but a week or ten days later I received the following letter:

> "Dear Sir:—I beg to inform you that in compliance with my promise, I submitted to our general executive board the premium plan for paying for work performed. I am instructed by the members of the general executive board to say to you that, owing to the fact of it being within a couple of weeks of our convention in Buffalo, they cannot see their way clear to take any action in the matter at this time, believing that some steps will be taken at our convention in regard to this and other plans in connection with operating machine shops.
>
> "I wish to say I have included in my biennial report to our convention your proposition in full, and I will let you know as soon as convenient after our meeting what action has been taken upon the same.
>
> I trust, therefore, that you will see your way clear to make no change in your present method of operating your shop until after our convention meets."

In my acknowledgement of this letter, I said:

> "If the delegates present at your approaching convention can be made to realize the distinction between the premium and piece-work systems, we have little doubt but that they will wish to have the premium plan incorporated in their platform. It guarantees full current wages to the poor workmen, benefits the mediocre, and obtains for the skilled far more than they are able to earn under the day's-work plan. Its action is, in fact, automatic—each workman being paid according to his individual ability to augment production."

I must, however, reserve for the next issue of this Magazine the history of the case in the convention—the delineation of the attitude of organized labor toward one of the most advanced systems for stimulating true economy and ensuring to labor its full share of the reward. It is significant of the tendency in the United States—a country which has heretofore won its industrial prominence largely through labor's freedom from the narrow views and narrow bonds which are cramping the older world.

RECENT NOTABLE SALVAGE OPERATIONS.

By Waldon Fawcett.

SALVAGE work on the high seas has progressed, in so far as the difficulty of work attempted is concerned, directly in proportion to the improvement in methods and facilities. In view of the fact, therefore, that marine wrecking operations are now undertaken which a few years since would have been regarded as utterly impracticable, if not foolhardy, it is perhaps not strange that the achievements of this branch of engineering science during the past year have exceeded in importance and interest those of any previous period in history.

The year 1899 has seen placed in service larger wrecking vessels and more complete equipment generally, and attendant thereon, the introduction of new methods which have proven successful in the highest degree. Moreover, in one case—that of the disaster to the American liner Paris—it has taught the greatest maritime nation in the world that, in point of efficiency, its wrecking plants and their operatives are surpassed by those of a new sea power.

The present era of notable salvage operations may be said to have begun, properly speaking, with the efforts to recover several of the Spanish cruisers sunk in the engagement at Santiago, Cuba, in July, 1898. The initial work, the raising of the cruiser Maria Teresa, was a decidedly arduous performance, particularly by reason of the governing conditions of wind and weather; but the methods followed in the prosecution can not be said to have shown any radical departure from those represented in previous practice. The loss of the vessel, while en route to an American port, brought the incident to a sudden termination. The official court of inquiry, to be sure, exonerated the officers in charge from any blame for the abandonment of the vessel, although it was stated incidentally that the failure of the pumps to clear the ship was due in a measure to neglect to have the bilges properly cleaned out.

The effort of Naval Constructor R. P. Hobson to interest the government in an effort to raise the cruiser Cristobal Colon by means of air bags, while it provoked considerable discussion at the time, resulted in no lasting beneficial results. That the scheme is practical under certain circumstances there can be little doubt, but that it would have justified the expenditure which would have been necessary in this particular case is extremely unlikely. Marine wreckers, for some time past, have employed air bags and made use of compressed air in varied manner; compressed air was utilized successfully as long ago as 1880 by George W. Dickie, manager of the Union Iron Works, San Francisco, in the recovery of the British ship Jessie Osborn. Mr. Dickie is still an advocate of the method, making the contention that, in view of the fact that one pound of air more than balances two feet of water, it is far more rational to pump compressed air into the hold of a sunken vessel than to endeavor to pump the water out. The main argument in favor of the air compressor as against the water pump is found, of course, in the fact that in the use of the former no

THE WHITE STAR LINER GERMANIC, RAISED AFTER BEING SUNK AT HER PIER, NEW YORK, FEB. 11, 1899.

energy is wasted. All of the air pressure applied is effective, whereas in the case of the pump usefulness is limited to the excess of the pump capacity over the rate of leakage. Obviously, the pumping method can only be successful in the case of comparatively small leaks.

The recovery of the former Spanish cruiser Reina Mercedes constituted the most important, as well as decidedly the most interesting, work of this character performed in West Indian waters. The work of raising the Mercedes was begun on January 2, 1899, and on March 1 she was towed into Santiago harbor. She lay on the brink of a ledge with 26 ft. of water inshore and 42 ft. outshore, with a list of 28 degrees. All the woodwork, including the officers' quarters, was torn out and the wreckers built a cofferdam on the main deck just forward of the bridge. In this dam 30,000 ft. of lumber, 6 tons of bolts and 800 yds. of canvas were used.

After the watertight dam had been pumped out the vessel rose and was towed into Santiago with 12 ft. of water in her hold. She drew on delivery at Norfolk, Va., only 22 ft. of water. All the guns, with the exception of two 16-cm. rifles, were taken off. The wrecking force had to overcome many obstacles. For instance, holes were found so large that they could not be caulked with pine corks and accordingly

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THE EX-SPANISH CRUISER REINA MERCEDES.

Sunk during the blockade of Santiago in the summer of 1898. The photograph was taken after she had been raised and brought to the United States.

STEAMER CITY OF WORCESTER, SUNK IN NEW LONDON HARBOR, MAY 29, 1898

had to be covered with iron plates. Pneumatic tools of American manufacture were utilized extensively in the operations, and by means of the drills over three hundred holes were drilled under water.

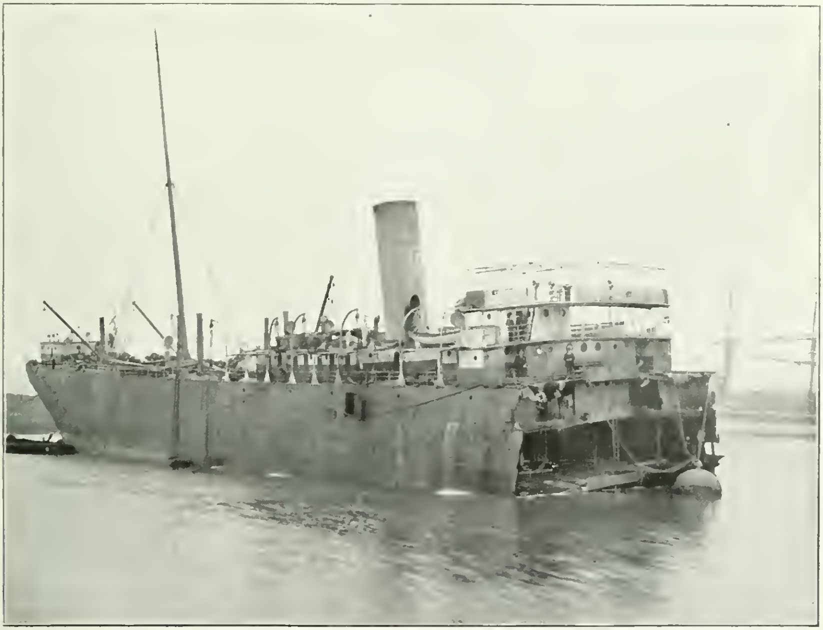
Probably the most remarkable achievement in the line of wrecking and rebuilding to be found in maritime history is represented by the reconstructed steamer Milwaukee, which was turned out in the summer of 1899 at the yard of C. S. Swan & Hunter, at Wallsend-on-Tyne, England. Something of the magnitude of the undertaking to make this vessel again fit for service may be imagined by a glance at the photographs herewith reproduced.

The Milwaukee, a vessel of 483-ft. length and 56-ft. beam, went ashore near Aberdeen in September, 1898, a huge rock penetrating the hold for a length of 30 ft. and to a height of 8 ft. above the tank top.

STEAMER MILWAUKEE AS SHE ORIGINALLY APPEARED.
She presents practically the same appearance since her salvage and reconstruction.

When the salvage operators saw that it would be impossible to save the entire vessel, it was decided to blow her in two with dynamite. This was done successfully and 180 ft. of the fore-end was left on the rocks, while the after end was towed to a dry-dock.

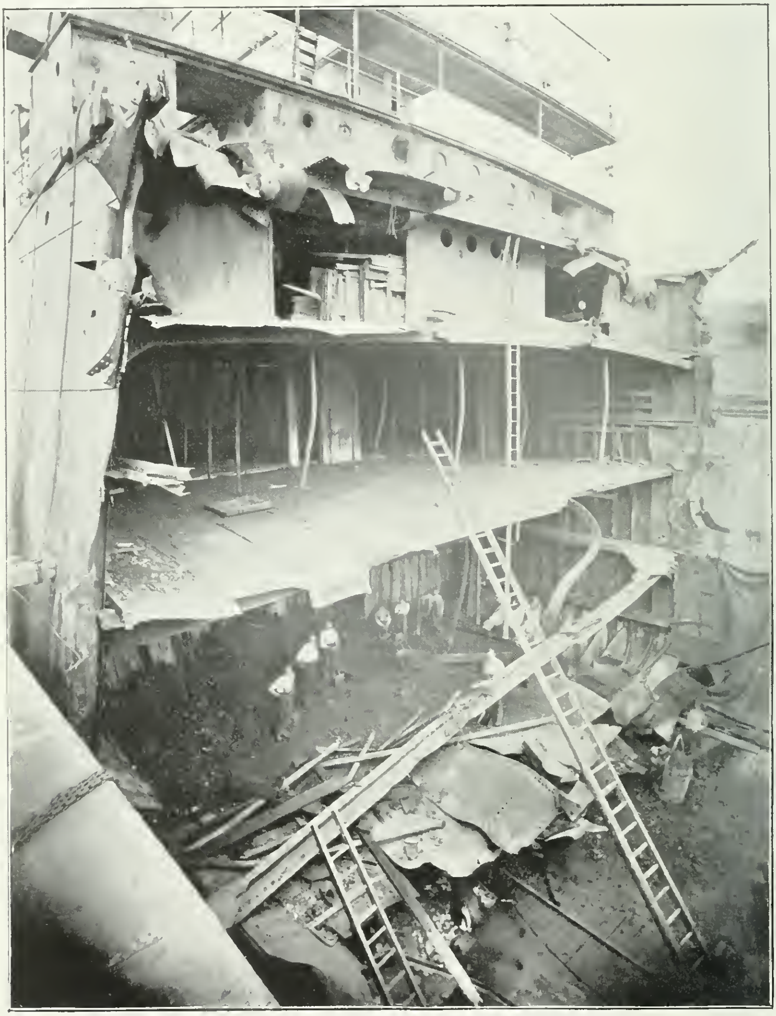
To sever the steamer, successive charges of dynamite were applied, each charge being distributed over a length ranging from 4 ft. to 6 ft., and the charges varying with allowance for the thickness of the steel plates to be severed. Such was the quality of the steel, however, that more than 520 lbs. of dynamite were utilized. Despite the heavy charges exploded, however, none of the parts of the structure adjacent to the belt of cartridges was seriously damaged.



THE SALVED PORTION OF THE MILWAUKEE MOORED IN THE RIVER TYNE.

The saved portion of the vessel depended for flotation, until placed in dry dock, upon a transverse watertight bulkhead at the forward end of the boiler space. The saved portion extended from just before the forward end of the navigating bridge to the stern, the engines and boilers being thus preserved. It was towed to the Tyne and moored in the river until a new bow was built, launched, and made ready for connection to it.

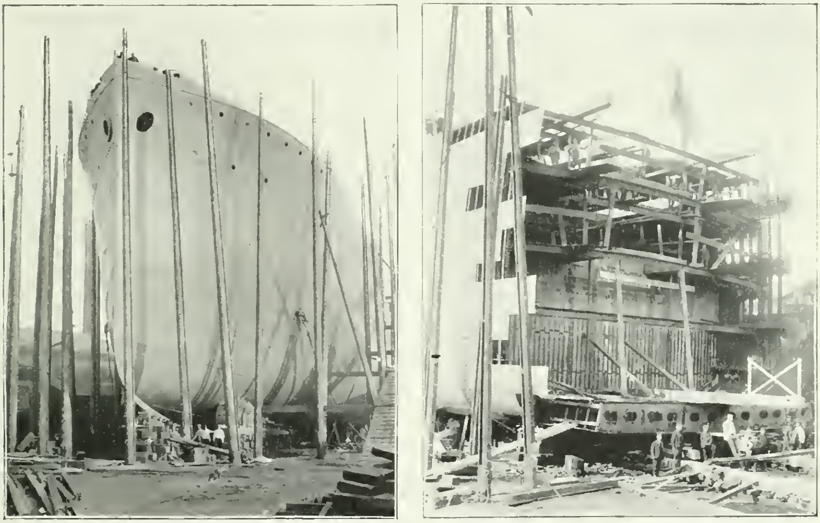
A remarkable feature of the removal of the after end of the Milwaukee was found in the fact that it was towed with the bulkhead end foremost, and that the tugs were assisted by the ship's own engines. On the arrival of the half of the boat at the Tyne, her builders set about the work of reproducing a fac-simile of the lost bow; so well did they succeed that a person ignorant of the facts would never know that he was not looking at the original bow, while even those persons who knew the circumstances of the case were unable to point out the



THE SALVED PORTION OF THE MILWAUKEE IN DRY DOCK, SHOWING THE EFFECTS OF THE DYNAMITE.

line where the junction of the new and old portions was made. Moreover, so successful was the attempt to dry-dock the two sections of the ship in correct relative positions that but little subsequent adjustment was necessitated.

Possibly the most creditable demonstration of the perfection of modern dry-dock methods was afforded by the precautions taken by Harland & Wolff, the Belfast, Ireland, shipbuilders, in the preparation for repairs on the Peninsular & Oriental liner China. The release of this vessel, after she had been for nearly five months on the rocks off the island of Perim in the Red Sea, was of itself so interesting an accomplishment as to warrant a few words in passing.



FORWARD AND AFTER PART OF THE NEW BOW OF THE MILWAUKEE.

On the stocks, ready for launching, at the yards of C S. Swan & Hunter, Wallsend-on-Tyne.

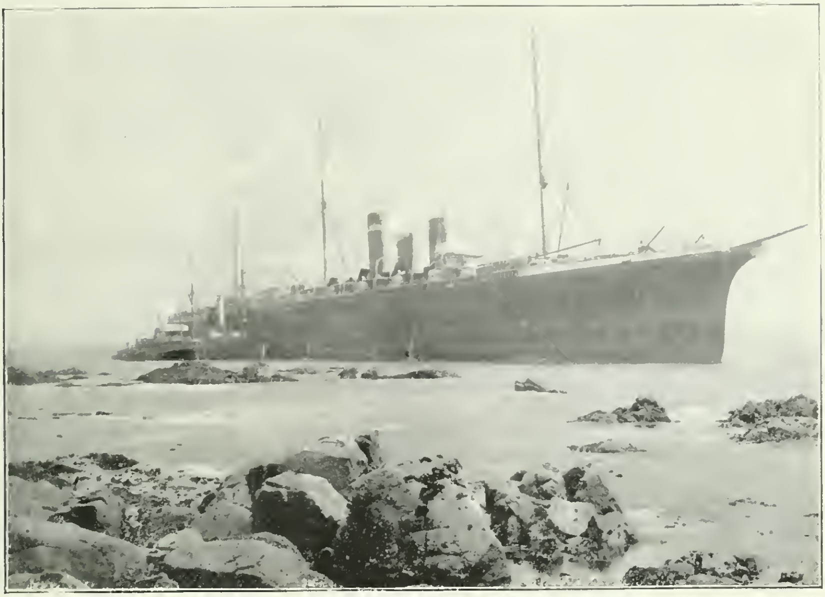
The China, a vessel of 500-ft. length, 54-ft. beam and 7,899 gross tons was, late in March, 1898, driven on a rock which made an immense hole in her double bottom. When the salvage steamers arrived, early in the following month, it was found necessary to remove the rocks by submarine blasting before any attempt could be made to fill up the holes. Continuous bad weather made these operations difficult, and several months of steady work were required before the divers finally began the task of tightening the steamer's bottom. About the middle of September the pumps of the salvage steamers, with an aggregate capacity of 14,000 tons of water per hour, were called into requisition and the work proceeded with little interruption.

When the China was brought back to the yard of her builders for repairs it was, of course, impossible to resort to ordinary methods of dry-docking, by reason of the condition of the vessel's bottom. Before the docking operations were undertaken, it was decided to carry the weight of the fore end of the ship on square timber logs of about 20-in. measurement, taken horizontally through the vessel from side to side. For this purpose holes of sufficient size had to be cut through the side plates and no fewer than sixteen of the logs were "rove" through the China, and under the projecting ends upright timber supports 16-in. to 18-in. square were fitted.

The supports rested upon shoes on the bottom of the dock, to which they were secured by braces, while the heels of the logs were strapped round as a precaution against splitting. Of course, all the uprights had to be cut before the ship entered the dock and positions were marked upon the bottom of the dock for the shoes to sit upon. A large number of timber shores were also fitted to assist the supports. A number of the latter were carried up from the bottom of the dock as uprights, while others were on various altar courses or steep sides of the dock, and so cut at the head as to take an angle plate which fitted close up under the edges of the overlapping shell plates. Altogether there were three rows of these supports, consisting of square pitch pine logs from 12-in. to 18-in. measurement.

When the water had been pumped out of the dock the injuries to the China were found to be of a most unique character. The bottom

THE STEAMSHIP CHINA BEFORE SHE WENT ASHORE OFF PERIM



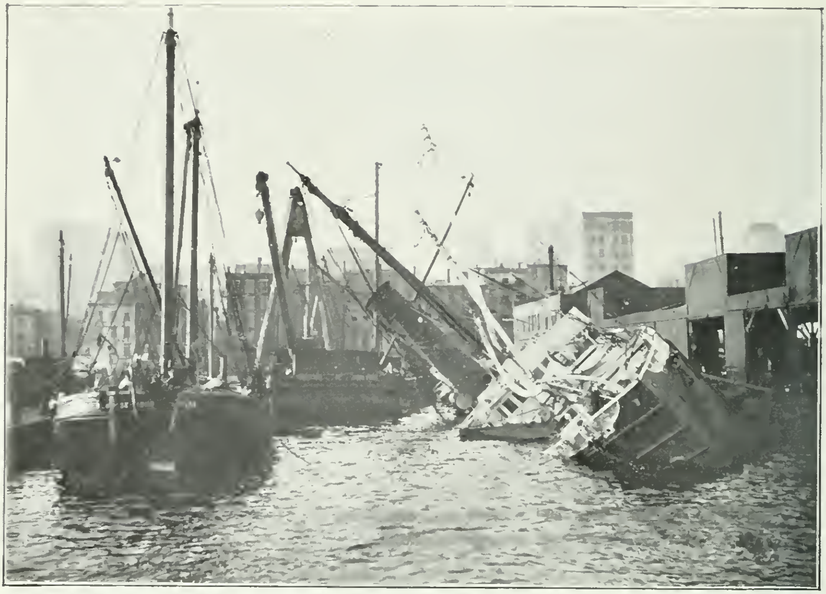
AMERICAN LINER PARIS ON THE MANACLES ROCKS.

of the ship was driven out of shape for a distance of fully 220 ft. from the stern, and the keel was arched for nearly 200 ft., being set up 9 or 10 ft. The plates were corrugated and dented in a most remarkable manner. Moreover, the damage was not confined to the forward end, there being a number of fractured plates only about 100 ft. from the stern.

The success of a Hamburg salvage corporation in floating the American liner Paris, stranded on the Manacles rocks near the entrance to the English channel, after British firms had abandoned the attempt, has very naturally caused an immense amount of comment. The whole effort of the British salvors was to pull the vessel off the rocks by means of tugs assisted by the steamer's own engines.

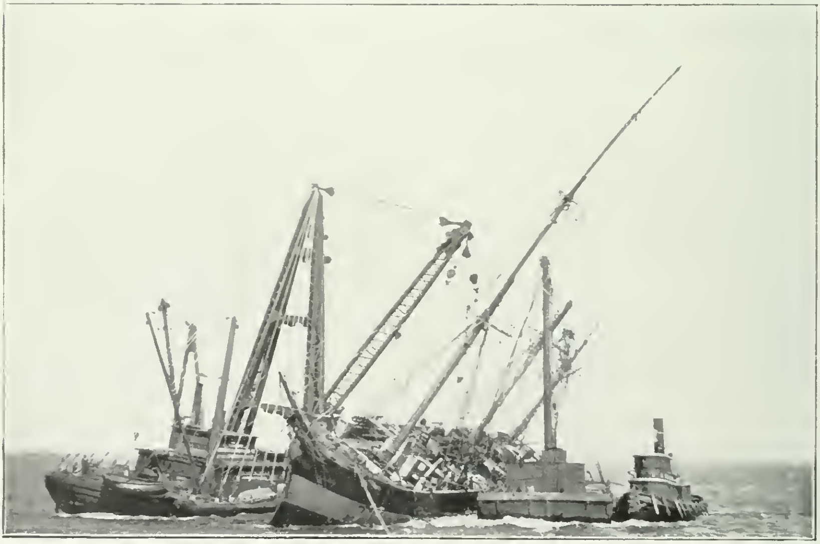
The Paris went ashore May 21, and the three large wrecking boats of the German corporation did not make their appearance on the scene until June 7. Just thirty-three days were consumed in the patching, blasting, and pumping necessary for the removal of the rocks which held the vessel. The inspection made by the divers disclosed the fact that a hole about 12 by 16 ft. in size had been made in the vessel's bottom by great pinnacles of granite, which had penetrated her outer shell about midships under the first and second boiler rooms.

The vessel rested, as it were, upon a great pivot. The work of the



MALLORY LINE S. S. LEONA, BURNED AND SUNK AT HER PIER ON THE EAST RIVER, N. Y., OCT. 5, 1899.

Righted and pumped out by the Merritt & Chapman Derrick and Wrecking Co.



RAISING THE BARK LA ESCOSESA, CAPSIZED AND SUNK OFF ROBBINS' REEF LIGHT, NEW YORK HARBOR, MARCH 23, 1899.

WRECKERS AT WORK RAISING THE SUNKEN STEAMER CATSKILL.

divers was seriously impeded by sea-weed as thick as jungle grass and 10 ft. high, and the removal of this was the first task undertaken. Later it was towed to a point where the tide caught it and carried it out to sea. The Germans early decided to abandon the plan of the British wreckers, which was to lift the vessel off the rocks by means

THE CATSKILL AFTER SHE HAD BEEN RAISED, PATCHED, AND PUMPED OUT.
The work was done by the Merritt & Chapman Derrick and Wrecking Co.

THE WRECK OF THE NORSEMAN, OFF MARBLEHEAD, MASSACHUSETTS BAY.

ROCKEFELLER STEAMER DOUGLASS HOUGHTON, SUNK IN ST. MARY'S RIVER AND BLOCKING TRAFFIC BETWEEN LAKES HURON AND SUPERIOR.

of pontoons and bags inflated with air and placed under the keel. Instead, they adopted the plan of blasting away the teeth of granite which held the liner.

Before this could be undertaken it was necessary to do an immense amount of patching from the bow aft to the midship section, and the steamer's bow was lifted out of the water by adding weight to her stern and filling her after compartments with water. The danger of injuring the vessel restricted the size of the blasts, but in all more than 15,000 cu. ft. of rock were removed; moreover, this was all done under water. As rapidly as the boulders were detached, hawsers were made fast to them and they were dragged out of the way by the wrecking steamers.

Difficulties of the greatest magnitude presented themselves when the work had advanced to the point at which it became necessary to blast away the last pillar of granite holding the Paris. The steamer had been filled with water flush to her depth of 50 ft., in order to raise her bow, and, inasmuch as her own pumps could not cope with this, holes had to be cut in her decks and sides in order that a powerful wrecking steamer might lie alongside and suck out the water ballast. As the vessel righted, the rush of water tore out some of the compartments and the engine rooms were inundated and the furnaces submerged. Scarcely had she been righted and her engine rooms pumped out when a gale sprang up which opened her seams and allowed her to fill again. To steady her during the storm and prevent her being driven farther on the rocks, anchors were carried out from the bow and stern on both sides, and the chain of the anchors kept taut by means of steam winches on the deck of the vessel. When the gale subsided, the boat had to be pumped out again and considerable additional patching done. The patches utilized were formed of shields of wood, fitted over the breaks and padded around with canvas and rubber. Some of the shields were as large as the door of a house. The actual releasing of the vessel was accomplished by setting in motion the steam winches connected with the chains of the stern anchors while the three wrecking steamers united simultaneously in a long, steady, pull.

Among the minor salvage operations possessing an unusual degree of interest it would be unjust to pass over the ingenious methods followed in floating the Warren liner Norseman, which went ashore in March, 1899, near Marblehead Neck, Mass. An examination showed that the greatest damage to the vessel was a jagged hole four feet square in the forward portion of the hull. The wreckers battened down the hatch on the lower deck and then held it tightly in place by a series of shores braced against the upper deck. The water filled the entire hold below the lower deck.

After these preliminary preparations had been made, the pumps, each throwing 2,850 gallons of water per minute, were put to work, pumping water, not out of, but into, the hold of the vessel; as a result, the water poured through the large leak with great force and, striking against the lower deck, assisted in buoying up the vessel. The large hole mentioned was located about 25 ft. from the bow on the starboard side. There were, of course, other holes of smaller dimensions all along the bottom as far aft as the engine room, but they were stopped in the usual manner with canvas and boards.

Although perhaps not generally known, the fact remains that some of the most perfect wrecking plants in the world are to be found on the great lakes of America. The whole equipment of these fresh water salvors is selected with a view to rapid work. The necessity for this is well illustrated by the sinking in St. Mary's River in September, 1899, of the steel steamer Douglass Houghton, one of the largest cargo carriers on the inland seas. Inasmuch as the wreck blocked practically the only deep-water channel between Lakes Huron and Superior the whole commerce of the upper lakes was virtually at a standstill.

Dynamite blasting was resorted to for the removal of the limestone rock into which the vessel had run her nose. A large portion of the vessel's cargo of iron ore also had to be transferred to lighters, as the shallowness of the stream made it impracticable to dump it overboard. The energy manifested, even in the under-water work, is evidenced by the fact that, although the hole in the Houghton's side was 2 ft. fore-and-aft and 7 ft. up-and-down, it was patched temporarily so that in thirty-six hours after she sunk the vessel was enabled to pump the water out of her hold with her own pumps.

EDITORIAL COMMENT

The entire naval-engineering world, on both sides of the Atlantic, has been waiting with great interest the formulation, by the United States navy department, of the rules putting into actual effect the personnel law, which was passed last March. The readjustment to modern conditions of the status of the engineer in the navy is the thing most vitally important to the efficiency of the navies of to-day, and sea-power is the most important factor in national ascendancy. THE ENGINEERING MAGAZINE has always advocated most strongly the principle of developing the all-around naval officer—trained both as an engineer and a military man, and capable of serving on deck or the engine-room—as a thoroughly sound one, and one which is absolutely essential to the preservation of naval power.

Attention has only recently been drawn to the fact that, in August last, the assistant secretary of the United States navy issued an order, known as General Order No. 524, ostensibly for the purpose of carrying out the personnel law; but, so far from carrying out its real purpose, this general order carefully provides that the express will of Congress shall be nullified; for it states in one paragraph "it is the Department's intention that, so far as practicable, commissioned officers shall be relieved from engine-room watch."

If this order becomes the established rule in the United States navy, it will be seen at once that the purpose of the personnel bill will be entirely set aside—and, curiously enough, the law will be violated by government officers who are specially charged to enforce it.

The seriousness of this feature, however, for the United States in general, is that it will take away, in a short time, all the wholly trained technical skill from the machinery of the great ships. For a few years, those of the former engineers who will be transferred to the line will be available to act as chief engineers of the ships; but under this system, as now, commissioned officers will be getting no training in engineering. When the former engineers are gone, the navy will simply have the skilled mechanics, who are handicraftsmen, but not engineers in the true sense of the term, directed by a dilettante who knows nothing of engineering from real experience.

It is to be observed that this is the very system which was in vogue in the Spanish navy in time of the late war between the United States and Spain, and the results of such a system have been demonstrated so thoroughly that it is simply amazing any government official should have been willing to father an order calculated to destroy the efficiency of the navy.

The only explanation for it is, that the actual author of this order was Admiral Crowninshield, the chief of the Bureau of Navigation, of the United States navy, who is charged with the routine work of the organization, and who was notoriously opposed to the personnel bill, having very frankly so expressed himself when a member of the personnel board. It is hard to believe that the assistant secretary ever read this order, and it can only be supposed that it was signed by being shoved in with a lot of other papers which are passed without examination.

Apparently, the people who persuaded Mr. Allen to sign this order have an idea that no one outside of the navy takes any interest in its efficiency. They will no doubt find that the engineering interests of the country, who pay their share of the taxes which build the big ships, propose to see that the machinery is properly cared for. Steps will no doubt be taken, also, to find out whether a plain law of Congress can be violated with impunity by officials whose business it is to carry it out.

* * *

Comment was made in these columns in the November issue, upon the general subject of indexing engineering literature, especial reference being made to such periodical issues as are made by THE ENGINEERING MAGAZINE, *Science Abstracts*, *Le Mois Scientifique et Industriel*, and other similar publications.

The matter is of sufficient importance to demand further attention, especially in view of the work which is proposed by the Boston Public Library in an allied branch of science. This index, for the present, is limited to the one subject of Physiology, but it is rather of the method than the subject of which mention is now made.

* * *

Ordinarily the index of a science, whether in card or book form, is intended to be a mere guide to the article indexed. In many cases nothing is given but the title and author's name, and as everyone knows, titles are often very doubtful clues to the substance of the articles to which they belong. The result is that the searcher must first consult the index and then send for a number of articles which he may or may not want, but about which he can tell little until he has examined them. The defect has been partially met in the case of the Engineering Index by the addition of a brief note or legend to the title, giving, as far as is possible in the very limited space available, a hint as to the character of the article, and in *Science Abstracts,* and in some other voluminous indexes, an abstract of the entire article is given.

* * *

In the case of the Physiological Index of the Boston Public Library it is proposed to furnish a full abstract of every article indexed upon the index card, these cards being printed and placed on file for consultation in the library, and also to a limited extent held on sale for those desiring to form private indexes. An index of this sort would constitute a classified epitome of the current state of the science to which it relates, and for many, if not most, users it would dispense with further reference to the original articles, while to the closer student, much laborious handling of undesired volumes would be saved. Being in card form, and kept closely up to date, it would be in better shape for general consultation than a book index, while so far as bulk is concerned the difference would not be a serious objection.

The real value of such an index, whether relating to physiology, engineering, or any other branch of science, depends almost altogether upon the skill with which the preparation of the abstracts is made. To boil down the substance of an article of several thousand words to a limited space such as is afforded by an index card, requires two distinct forms of ability, the one being a capacity to absorb the true value of the original, and the other the ability to condense the substance of it into a paragraph or two.

Many men possess one or the other of these faculties, both are rarely found in the same person. Properly executed, such an index, covering all branches of science, would be hailed with enthusiasm by scientific workers all over the world, but the magnitude of the task is one which demands careful thought and cautious investigation lest the attempt fall far short of the conception.

* * *

The annual report of Secretary Long, of the United States navy, has just been issued, and manufacturers will be both surprised and amused to see the secretary's ideas of the way to secure an increased efficiency in the administration of the department. He proposes to consolidate the three largest constructing bureaus, namely, Equipment, Steam Engineering, and Construction, under one head for the alleged reasons of economy and harmony. If Secretary Long knew anything about manufacturing or the conduct of any large business, he would realize the absurdity of this claim, for what will actually occur will be that, instead of three independent heads of the co-ordinate bureaus, each of whom will have a ready access to the head of the department, there will be one head of the co-ordinate bureau, with three assistants who will do the same work as done by the bureau chiefs. As for any reduction in the clerical force, the experience of the entire department would teach exactly to the contrary; for a somewhat similar consolidation on a smaller scale, as we are informed, multiplied the clerical force several times and the amount of red-tape many fold, instead of making any reduction.

The commission of such an economic mistake as consolidating these bureaus on the ground of harmony is simply a confession of weakness. The Secretary of the Navy is really in exactly the position of the general manager of a great railroad or manufacturing corporation; the bureau chiefs correspond to the heads of the departments. If a competent manager found that his heads of department were wrangling, he would not attempt to avoid the difficulty by consolidation of the departments between which there was friction, but by finding the man who caused the friction and by giving him to understand that if his polemic spirit were not curbed, he would have to seek a field of usefulness elsewhere. It is an open secret to those having dealings with the United States navy department that the lack of harmony said to exist has been systematically brought about by one man, or set of men, who were working to give the Secretary this "lack of harmony" as a basis for his scheme of consolidation. We have rarely known of a more melancholy spectacle than that afforded by the head of a great department of a great government confessing his inability to maintain discipline in his own department and running to the legislative body with schemes for relief.

The relation which technical and engineering education bears to the development of the commercial side of engineering is being realized now more strongly than ever before, and some writers go so far as to say that it is upon methods of technical instruction alone that future progress must largely depend. While this is true to some extent, it must be remembered that education cannot create, it can only develop that which is already there.

At the same time there is a disposition among technical instructors to follow instead of to lead, in that they endeavor to provide an instruction based upon the methods of the past rather than to endeavor to consider that much of what has formerly been satisfactory will have to be unlearned. There has been a great clamor for technical instruction which will fit the youth for the workshop, and in the endeavor to meet this demand the conditions of the workshop of the past have been taken as an indication of the kind of instruction which is required. Assuming that machinists can be made in the trade-school, an assumption which many are not prepared to admit, it is a matter of some curiosity as to what these machinists are to do when they are made.

* * *

It is clearly evident that there is a great transformation going on in shop methods, which calls for an entirely different kind of mechanic from that produced either by the old method of apprenticeship or the newer method of the trade school. The nature of this revolution has been clearly shown in Mr. Roland's papers, which are now appearing elsewhere in this Magazine, and for a modern machine shop, fitted largely with modern automatic tools, using all possible appliances for utilizing repetition methods, something altogether different from the ordinary machinist is needed.

* * *

Among the various matters of interest brought to the attention of the members of the American Society of Mechanical Engineers at the recent convention in New York, the movement to erect a memorial to Robert Fulton is especially worthy of mention. The body of Fulton now lies in the Livingston family vault, in Trinity churchyard, New York, but there is no outward indication to guide the visitor to his resting place, and it is this omission which the society seeks to rectify.

There could hardly be a more appropriate location of the tomb of the man to whom the development of steam navigation is due than this quiet spot in the midst of the busiest portion of the metropolis. The greatest steamers of the world ply back and forth in waters of the rivers and harbor within a stone's-throw of the grave, and one might here truly say, as of Wren in St. Paul's, *"Si monumentum requiris, circumspice."* About the quiet churchyard are grouped the buildings in which the business of the great steamship lines is transacted, and from the foot of the street where the monument will be placed is the starting point of some of the swiftest vessels on the bay. Everything is here combined to make the associations join to perpetuate the work to which Robert Fulton devoted his life, and there is no more fitting body to whom the erection of a memorial could be entrusted, than the American Society of Mechanical Engineers.

REVIEW OF THE BRITISH PRESS

The Congestion of City Streets.

THE address of Sir John Wolfe Barry before the Society of Arts, published in a recent issue of the *Journal* of the Society, is devoted to a subject which, while of pressing importance in London, is also becoming a serious one in other great cities. This address reviews the similar one delivered by the author at the last session, and shows how the various points then made have become still more important.

A great portion of the crowding is due to the fact that improved means of transportation have rendered it possible for residents of suburban districts to become daily travellers to and from the heart of the metropolis, and from suburban and Greater London streams of people are constantly passing in and out of the strictly urban portion of the metropolis, thronging the streets, many of which were made when the number of inhabitants was one-fifth or one-sixth of the present total. It is estimated that 960,000 people enter and leave London daily by railways alone, and that the number of roadway vehicles has trebled in the last 27 years. It needs no especial argument to show that traffic has overtaken the means for accommodating it, or that the main lines of arterial communication are intolerably crowded.

One attempt which has been made to obtain a little relief has been the police prohibition of empty cabs moving about in search of fares, but this has apparently only changed the character of such obstruction, since it has led to the establishment of long cab ranks occupying the middle of great thoroughfares already too narrow and too crowded. It is not only the number of vehicles passing which is the measure of the capacity of a street, since there should be sufficient width to permit differences of speed, and to allow vehicles capable of speed to pass the slower ones.

Any attempt at relief in a city like London must necessarily be very expensive, but the real question lies in the cost of not obtaining relief, and hence it is important to find out how much money is being lost by submitting to the present state of affairs, and if such loss can be shown to be greater than the cost of improvements the relief may appear an economy after all.

It is by no means easy to arrive at a fair valuation of the money loss caused by delays to traffic in crowded streets, but the computation in the paper shows that on four of the principal thoroughfares in London each day there are 16,650 omnibuses, 14,900 cabs and carriages, and 9,700 carts and other vehicles impeded and delayed. By a comparison of a number of cases an average delay of 20 per cent. is taken as being fair, and a similar averaging of values gives the mean value of the traffic in these streets as £1,631 per hour, and the loss upon this reaches the total of £880,740 per annum. This applies to vehicular traffic alone, and if to it is added a loss, similarly computed, for Euston Road, the figures for the loss to vehicles alone may safely be put at £900,000, on these streets. The losses at crossings must also be computed, and in addition there is a general loss to trade interests, due to overcrowding and also the delay to pedestrians, and summing all these, the total annual loss to London on the limited area above considered is given as £2,154,000.

While these figures can make no claim to high precision they are undoubtedly within the limits of the truth, and this being the case it can be seen that a large expenditure would be warranted in order to obtain relief. Sir John Wolfe Barry offers some suggestions as to the most available method of obtaining relief, which in his opinion could be attained by the construction of certain subway and viaduct crossings and turnouts, by means of which the most congested spots would be greatly relieved. These can hardly be described without maps, and are not offered as a final solution of the problem, which really demands the opening up of new and wider highways, but the time required for any permanent improvement makes it most desirable to attempt some temporary amelioration of the existing conditions as soon as practicable.

In this connection it should be remembered that a great and immediate relief could be obtained by the general introduction of motor vehicles. It is apparent that at least one-half the space required by a horse-drawn vehicle is saved by the use of the automobile, while the facility of manipulation in turning and backing in a very limited space makes the clearing of blockades a much simpler matter than is possible with horses. With automobile cabs and omnibuses the congested streets of London would be immediately relieved to a very great extent, and in the respite thus gained permanent improvements might be planned and conducted upon the best and most economical lines.

Engineering Progress in England.

Presidential addresses are not always interesting reading, but when an engineer of the eminence of Sir Douglas Fox speaks as its presiding officer before the Institution of Civil Engineers, the remarks may well be expected to contain much that is worthy of thought and review. This is especially the case at the present time when there is such an active discussion of all the problems connected with both the constructive and the commercial side of engineering. As Sir Douglas Fox well remarks, it is only a short time since Great Britain was the workshop of the world and the educator of all the nations in mechanical science. With the development of technical education on the Continent, however, all this has been changed, and much is to be learned from foreign engineers, notably from those of France, Germany, Italy and Switzerland, as well as from Anglo-Saxon America.

The early portion of the address includes a review of the history of engineering in Great Britain, from the work of Murdoch, Telford, the Rennies, and the Stephensons, not to mention other names of the notable list, showing the prominent part which England has taken in the technical progress of the century. Coming then to the active problems of present engineering work, these are taken up and briefly reviewed in succession, the whole forming a comprehensive presentation of the field.

It is only possible in the limited space here available to comment upon the salient features of the address, and the original must be read by those who desire the whole. It must, therefore, be understood the points here discussed have been selected for their timeliness, and do not represent in any degree the scope of the address. A conspicuous feature is the emphasis which, in various portions, is laid upon the repressing influence of state and municipal control of engineering work, particularly in the development of new enterprises. This is apparent in the slow progress which has been made in England in the introduction of electricity, in its three great applications of lighting, traction and the transmission of power.

"Hampered by restrictive legislation, opposed by vested interest, and encumbered by the by-laws and regulations of official bodies without number, the electricians, who form so important a branch of the profession, have been unable to do justice to their skill. A few railways, especially designed for city traffic, and a comparatively insignificant length of electric street tramways, have struggled into existence. Some rather better progress has been made with lighting in the chief towns, but it is discouraging to compare the present position of electrical industries with that of similar undertakings in the United States, Switzerland, Germany, Japan, and even in the British colonies."

Another feature in which progress is retarded in England by local restrictions is fond in connection with the development of water rights, both for water-supply of cities, and for the generation of hydraulic power. While in Great Britain discussions are conducted with reference to the right to carry water from one watershed to another, vast installations are being rapidly established in Germany, Switzerland, and the United States, where difficulties of this kind are readily swept away if found to impede industrial progress. "Mechanical traction upon public roads has been, and still is, most seriously hampered by restrictive legislation in Great Britain, which, with all its enterprise, is very slow to adopt improvements involving any change in the ordinary course of life. Whilst American and foreign engineers have been able to build and run motor cars for a long time past, it is only quite recently that such carriages have been allowed to travel in England, except with a red flag in front and at a foot's pace. Even under the new act, which has given impetus to this important industry, the limitation of the weight to three tons, instead of four tons, prevents many valuable improvements from being adopted; and by rendering necessary the introduction of aluminum and other costly materials, has kept the price of such carriages at a prohibitive figure for general use."

"The question of the congestion of traffic in London alone, renders it advisable to consider the importance of the motor vehicle as a means of relief, and we may look forward to the time when horses shall have given way, in towns at least, to mechanical traction, avoiding offensive smell, reducing noise, and wear and tear, and enabling asphalt pavement to be used throughout with cleanliness and safety."

These are but few of the current engineering problems in which British engineers have been compelled to see themselves distanced by their professional brethren in other countries through no fault of their own, but solely because of the peculiar local difficulties with which they have had to contend. While the restrictions are gradually being removed or modified their effect cannot fail to constitute a serious handicap by reason of the great start which has been given to energetic and industrious competitors.

There are many other portions of the address which are filled with interest for the profession and for the world at large, but it is by its serious warnings of the above nature that it is chiefly characterised, and coming from such a source, delivered to such an audience, these significant utterances should meet with prompt and effective recognition.

The Electrical Distribution of Power.

THE introduction of electric driving into machine works is a question meeting with much discussion at the present time, and the paper of Mr. John S. Raworth before the Manchester Association of Engineers brings out some points in connection with the practical working of electric distribution of power which are of interest.

In some lines of work the advantages of electric driving are so obvious that no discussion is necessary; such a case is found in a shipyard, where many isolated tools are spread over a large area. In other cases, as in various engineering establishments, the convenience of electric power is evident, but the question of the economical advantage of making an expensive change requires consideration. When we come to the work of the cotton spinner and manufacturer, where everything can generally be arranged so as to permit mechanical driving to the best advantage, it is difficult to show how electric driving can be substituted to financial advantage.

The subject is necessarily bound up with that of the cost and efficiency of the motors. A comparison of prices of motors by reliable makers shows that the price for motors is naturally proportionally greater for the smaller sizes than for the larger, so that an extreme subdivision of power, using small motors for every machine, involves a much greater first cost than is required for a single motor of the capacity of all the small ones. As a matter of fact it is not necessary to have power enough in a single motor to drive all the tools in a workshop at one time, as a portion are always standing, while with independent motors, capacity must be provided for all, since no motor can drive any but its own machine.

So far as efficiency is concerned, it must be remembered that mechanical and commercial efficiency are by no means the same thing, and a plant with a high mechanical efficiency may involve such charges for interest, depreciation, superintendence, wear and tear, etc., as to render it less efficient commercially than one less complete technically.

The true method of attaining high commercial efficiency with electric driving lies in the establishment of large generating stations, enabling the fixed charges to be reduced to a minimum, and supplying power to a number of consumers at as low a price as the use of large-scale efficient machinery will permit. The observation of Swiss methods made by Mr. Raworth, during the recent visit of the Institution of Electrical Engineers, caused him to state that he believes that all the Swiss factories will be electrically driven within ten years. This, however, is in a land of cheap water-power and dear coal, but in England it is possible to generate cheap electricity with large plants using steam power.

Mr. Raworth gives an estimate for a plant of 50,000 horse power in which he shows that the yearly cost may be taken at about £2 per horse power for factory hours, or double that for continuous service, but at the present time the price for supply by corporations is more than double these rates.

The advantages of electric driving in machine works amount to much more than any direct economy which can be taken from the cost of the power, and the increased efficiency of the plant as a whole, due to convenience of handling, possible better arrangement of tools, and general increased output, must be taken into account in making an intelligent comparison. The one item of better arrangement of machinery will appeal to every works manager who has found himself hampered in placing machinery by considerations involving the getting of the motive power to the tool, and the ease with which valuable space can be utilised to best advantage is a matter well worthy of consideration. Probably the change will come about by the gradual introduction of group driving in the older works, and complete independent driving in the newer establishments, and as the development of central supply stations reduces the cost of generation the commercial advantages will become more and more apparent.

Mr. Raworth's paper contains a valuable appendix compiled from a number of sources, giving the power required for various machine tools, and while this is intended to serve as a guide for the selection of motors for separate driving, it will doubtless be found useful in other connections.

The Cost of Steam Raising.

In all modern manufacturing operations the cost of the power required is a matter of constantly increasing importance, and the interest which is taken in this element of manufacturing cost is shown by the number of papers devoted to the cost of power presented before the various engineering societies. The cost of steam power has especially been given consideration since the revival of water-power development for electrical purposes has brought about a competition which was formerly not in existence, and to electrical engineers the questions involved are of much importance.

The cost of steam raising has recently been discussed very fully in a paper by Mr. John Holliday, presented before the Institution of Electrical Engineers, and from this paper some abstracts are made.

We may practically consider the fuel as the raw material and the steam as the manufactured product, the other elements of cost in a properly managed plant usually being a small proportion as compared with the coal. It is only in the centre of the coal fields, or in some other equally favoured spot that the cost of the coal will be anything less than 50 per cent. of the whole, the exceptions mainly being such instances in which waste materials and by-products are used; and even in these cases the cost of handling and transport often serves to render the economy of such fuels problematical.

The fuel question often comes down to a comparison between the real economy between high-class and inferior coals, and several points are to be considered in making such a comparison. From a purely theoretical standpoint the inferior fuel should be the more economical, since the difference in cost more than counterbalances the lower heating value. As a matter of fact the practical advantage is generally with the cheaper fuel, but as there are always some losses which partially offset expected gains, it is important to examine the disadvantages which attend the use of inferior fuel.

"In the first place, in order to get the same amount of heat with a low-quality fuel as with a higher quality under similar conditions, more fuel must be burned in the same time; then, if the boilers and furnaces are already working up to their full power, either more boilers and furnaces must be put down, or the present furnaces must be enlarged, entailing an expenditure of capital, the interest of which must be set against the extra economy attained; or else the fires must be worked harder, perhaps by the use of forced draught, causing the furnace gases to leave at a higher temperature, and thus carry to waste a larger portion of the heat in the fuel than formerly. The mere fact of more fuel having to be fired into the furnaces every hour will entail more work upon the stoker, for which extra wages will have to be paid, either to the same or to additional men. The extra amount of fuel used will cause the fire doors to be opened, in the case of hand-fired furnaces, more frequently or for longer periods, both for firing and for cleaning fires, whilst the extra amount of refuse taken from the furnaces will carry to waste a correspondingly larger amount of heat, and, what is more important, will often cost a great deal more in removal, particularly in busy manufacturing centres. Extra storage and space for fuel may have to be provided, and the wear and tear of the furnaces increased according to the extra amount of steam used, and not according to the amount of steam produced. Low-quality fuels, too, as a rule, require a stronger draught to burn them to the best advantage than better qualities; this may necessitate an expenditure for more chimney power in the case of natural draught, and larger fans and engines, using more steam to drive them, in the case of forced draughts."

"In substituting inferior for better class fuels we may expect a reduction in the cost of the fuel, depending on the differences in the ratio of calorific value to price of the two fuels, and an increase in working expenses, etc., depending on the increased amount of fuel used."

As an example of how all this works out in practice Mr. Holliday gives some interesting data concerning a battery of Lancashire boilers in which he is interested, and gives in tabulated form the results with different fuels and methods of firing. Out of nine boilers, three are fitted with Perret grates for burning breeze, while the others have ordinary bars and are hand fired.

The details of the trials are given in the paper, and experience showed that with breeze at 3s. 6d. per ton and Welsh coal of good quality at 14s. 6d. per ton, the cost of evaporating 1,000 gallons of water was more than two and one-half times greater with the Welsh coal than with the breeze.

An important portion of the paper is a tabular analysis of the distribution of all the costs of steam raising, including boilers fired with breeze and using forced draught, boilers fired with coal and using natural draught, and spare boilers worked under less favourable conditions than the other batteries. In this table it appears that with the forced draught the cost of evaporating 1,000 gallons of water was 7s. 3.54d., as compared with 9s. 2.12d. for the natural draught, although the latter were evaporating proportionally a greater quantity of water. In the case of the forced draught boilers, the fuel cost formed only 43 per cent. of the whole, while for the natural draught the fuel was 73 per cent. of the cost, this showing clearly the greater proportion which the handling and fixed charges bear to the fuel in the case of the cheaper material. These charges include working expenses, such as wages, handling, lighting, etc., maintenance, insurance, interest, depreciation, taxes, and superintendence, and the tabulated form given should form a very interesting study to all interested in steam making.

American Competition Again.

THE series of papers by eminent English and American authorities in engineering, which was reviewed while yet in progress last month, has been continued with able contributions from Mr. G. N. Barnes, the secretary to the Amalgamated Society of Engineers; from Mr. Oberlin Smith, a well-known American manufacturer, and past-president of the American Society of Mechanical Engineers, and from Mr. Archibald P. Head, the latter certainly well familiar with engineering and commercial work on both sides of the Atlantic.

As might have been expected, the correspondence columns of *Engineering* contain many communications upon various phases of this many-sided subject, and the whole is of sufficient interest at the present time to warrant further notice.

Some excellent points are brought out in the correspondence, among them being one to the effect that both Great Britain and the United States are at the present time in an abnormal condition as regards the demand for the products of industry, and that as this demand set in a little later in the United States than in England, it is but natural that certain British orders should be filled by American manufacturers.

The question of standardisation has also attracted much attention, and while its immediate commercial advantages are conceded, its ultimate influence in lowering the individual status of the workman is pointed out.

The contribution of Mr. Barnes to the symposium is a matter of especial interest, not only from the fact of his position as the representative of organised labour, but also because some of the views expressed by him have been disowned by members of the A. S. E., and as strongly indorsed by well-known employers of labour. Mr. Barnes admits the advantages of specialisation, and agrees that British conservatism has kept tools and methods in use which have practically been abandoned in America. At the same time he maintains that in the present demand for the products of the machine works England is getting fully her share of the orders, and sees no cause for alarm. So far as the retention of old-time tools and methods is concerned, Mr. Barnes very truly points out that unions cannot be held responsible for this state of affairs, since these conditions also obtain in industries in which no unions exist.

Mr. Oberlin Smith maintains that the primal underlying cause of success in America is due to the fact that the people are mostly descended from Englishmen, and that the English character is stimulated by the new environment. While the literal exactness of this statement may be questioned, there seems to be little doubt that the greater number of those Americans who have been active in the development of manufacturing and mechanical industries in the new world have been of British descent. It is a matter of observation that the modifications produced in native born Britons by the struggle to develop colonial success have resulted in the formation of individual characteristics closely resembling the more enterprising class of Americans. Mr. Smith calls attention to the fact that it is mainly in the smaller things, such as watches, pistols, sewing machines, light machine tools, etc., that American competition has been most successful, England holding her own in the case of ships, and similar large work, the locomotive and bridge cases, about which so much has been said, really being exceptions, and the hint is made that American methods are furnishing object lessons to other nations, the learning of which will soon help to equalise matters. Mr. Head carries the matter further than does Mr. Oberlin Smith, and while conceding that small products have been sent to England from America for many years, says that the competition with heavy work has now begun.

In examining the historical side of the question, it is shown that the commercial and manufacturing supremacy of England may be dated from the close of the Napoleonic wars, when the industrial progress consequent on the invention of the steam engine, began to develop. During the succeeding 60 years England came to regard herself as the workshop of the world, and being practically without competition, she considered this the normal condition of affairs. The last 20 years, however, have seen the development of American and Continental competition, and the question remains as to whether this competition may not be of the nature of an equalisation.

Mr. Head sees this fact clearly and meets it squarely, without attempt at evasion. After noting the conditions of labour, transport, and living, as existing in the United States, together with the competitive advantages gained by the powerful commercial organisations now so prevalent, he goes on to face the question as to what can be done to regain England's old position in the industrial world. "The English people will probably never do that, and will have to be content with a share of the world's commerce. But much can doubtless be done to prevent further retrogression, whether relative or actual. The conservatism of Englishmen must be broken down, and they must be content to learn from their American cousins."

That all this means only a friendly rivalry is clearly seen, and the key note of the discussion in this respect is not unsatisfactory, since it indicates a competition, which means, not industrial warfare, but rather association for the development of those qualities which shall make the Anglo-Saxon industrial supremacy assured throughout the world.

REVIEW OF THE CONTINENTAL PRESS

The Charlottenburg Centennial.

THE recent celebration of the one hundredth anniversary of the founding of the Royal Technical High School at Charlottenburg, near Berlin, calls attention to that important institution; and the great influance which its work has exerted upon technical education as well as engineering practice renders it desirable to give some notice of the event and the institution which it concerns.

Technical instruction, in the modern sense of the term, appears to have originated in Prussia during the closing years of the reign of Frederick the Great, and in an account of the growth of the present Technical High School given in the *Zeitschrift des Vereines deutscher Ingenieure* some interesting and amusing facts appear about organization of the military engineering school from which the institution descended.

The present school was formed from the union of two institutions, the Bauakademie and the Gewerbeakademie, and it is from the foundation of the former, in October, 1799, that the recent anniversary is computed. The older institution, as its name indicates, was mainly devoted to instruction in architecture and building construction, and numbered among its first professors the name of Eytelwein, who subsequently became its Director. The work of the Bauakademie gradually extended into the field of civil engineering, especially in relation to surveying, and the details of civil construction.

Meanwhile the Gewerbeakademie, under the able direction of Wilhelm Beuth, had been established, this institution being devoted to instruction more strictly technical in its character. In addition to a general foundation in mathematics and general physics, the courses included studies in mechanics, applied chemistry, industrial technology, and a certain amount of manual training. Among the instructors we find such well-known names as Wedding, Brix, Dove, Grashof, and later Reuleaux, Slaby, Wagner, Riedler, and others.

As might be expected, much of the work done by the two institutions was in a common field, and in the rapid development which came to both after the formation of the empire in 1870 it became evident that there would be much advantage in union. In 1879, therefore, the two older institutions were merged into one, under the name of the Berlin Technical High School. The increasing numbers of students, and the general demand for better accommodations soon led to the undertaking of new buildings, and in 1884 the present magnificent buildings at Charlottenburg were dedicated. Even these quarters are now become too limited; originally planned for 2,000 students, they are now compelled to serve for more than 3,400.

The influence of this institution on engineering and technology in Germany has been very profound, and to its work much of the rapid advance which has been made in the industrial development of the empire is undoubtedly due.

The celebration of the centennial anniversary was conducted with much enthusiasm, the Emperor delivering an address in which among other things he referred to the remarks of his grandfather, the Emperor William I., upon the occasion of the formation, fifteen years before, of the present institution by the union of the two older ones.

The Emperor also announced that hereafter the institution would have the authority to grant the doctor's degree, both honorary and in course, thus raising it to the level of a university and showing very clearly the revolution which has been wrought in Germany, so far as the relative standing of the two classes of institutions is concerned.

The most notable feature of the celebration was the unveiling of the two fine bronze statues of Werner von Siemens, and Alfred Krupp, these being placed in the grounds before the buildings of the High School, and fitly representing the embodiment of applied science in the persons of two of its foremost representatives.

The attendance at the celebration of representatives of most of the greater German universities showed the standing to which a technical school has attained in the esteem of the older institutions; and those countries which still discern in their own educational institutions a tendency toward discrimination by the advocates of the older learning against the newer education, may well take note of the harmony which exists in Germany.

The influence which a practical technical education has upon the material development of a nation may well be learned by example; excessive conservatism in educational matters has sometimes retarded national progress to as great an extent as has unprogressiveness in other more conspicuous directions.

It is the men who know how to do things, and who look and think, and act for the future, who make for progress; while those who devote their thoughts and studies to nothing but the past, however good their work, are only contributors to our knowledge of what has been done, a knowledge which, however interesting, makes but indirectly, if at all, for the progress which should be our high aim.

Space Telegraphy in the Alps.

Nearly all the experiments with space telegraphy which have hitherto been made public have been conducted at or near the sea level, being made between the shore and a vessel or lighthouse, or between one vessel and another. We now have a communication to the French Academy giving the results of the experiments of MM. Jean and Louis Lecarme communicating between Chamonix and the summit of Mont Blanc, and from the note in *Comptes Rendus* some account of these interesting trials is abstracted.

The horizontal distance between the stations in these experiments was not great, being only 12 kilometres (about 7½ miles), but the difference in altitude is very great, Chamonix being about 1,000 metres above the level of the sea, and the height of the Vallot observatory, near the summit, being 4,350 metres, a difference of 3,350 metres (about 11,000 feet). The rock between the two stations consists entirely of mica schist, the upper portion being entirely covered with ice, and the lower part with alluvium and glacial moraines.

The original intention of the experimenters was to solve the following questions in connection with space telegraphy, namely: 1. Whether space telegraphy is practically possible in mountainous regions; 2. If atmospheric electricity would interfere with the communication; 3. Whether the absence of moisture from the ground would have any influence upon the result; 4. What influence would be produced by distant storms?

The apparatus used possessed no especial peculiarities. The transmitter had a normal sparking length of 18 centimetres, which was reduced to 2 centimetres when the communication was made between the ground and the terminals on the pole. The latter was 25 metres in length, extending into the air at an angle of 30°.

The receiver, situated in the Vallot observatory at the summit, consisted of a very sensitive coherer filled with gold filings, this having been furnished for the especial purpose by M. Branly, and a dry battery, telegraphic relay, and tapper. The latter was so constructed as to interrupt the current automatically before tapping, this arrangement permitting a very light tap to suffice for decohering, thus maintaining the sensitiveness of the coherer very nearly uniform during the whole of the experiments.

According to the summary of results given in the paper, the difference in altitude did not seem to interfere with communication, but when the distance between the balls of the oscillator was less than 2 centimetres the signals were not always clear. The condition of the soil and of the atmosphere produced no effect, there appearing to be no interference due to the frozen condition of the ground, or to the presence of clouds and fog between the stations.

The influence of atmospheric electricity appeared only by causing action in the receiver, but apparently this did not interfere during the transmission of messages.

The most important result of the investigation, apart from the demonstration of the success through great differences in altitude, was in an unexpected direction. It was found that the operation of the electric lighting plant of Chamonix produced a powerful effect upon the apparatus, so much so that it was impossible to maintain communication between the stations during the hours when the lights were in service. The lighting system there in use is operated by a three-phase current of 2,500 volts pressure, but as the circuit is closed upon itself. without the formation of sparks, it seems as if the coherer is sensitive to other influences besides that of a direct discharge. While this action has as yet not been further investigated, it is possible that it may lead to the introduction of some other form of transmitter than that using the high tension discharge.

The Study of Fuels by X Rays.

ALTHOUGH the earliest practical applications of Professor Roentgen's discovery were in the domain of surgery, other uses outside of the physical laboratory are gradually being developed.

Among these is the application of radiography to the examination of coals, and from an article by Herr F. Kotte in *Stahl und Eisen* the following abstract is made:

It is well known that the rays do not pass through all materials with equal facility, and that there are some substances which offer a marked opacity to them. Both wood and crystallised carbon in the form of diamond, are practically transparent to the X rays, and, as might be expected, the various forms of carbonised wood are also readily traversed. When, in addition it is understood that the usual impurities in coal, such as slate and pyrites, are practically opaque to the rays, it will be seen that radiography offers a means of detecting the non-combustible in a piece of coal without necessity of the destruction of the specimen.

Herr Kotte refers to the earliest researches in this line of investigation by Dr. Thorner in 1897, but the latest work in this line has been done by Professor Couriot at the Ecole Centrale, in Paris, and the radiographs made by the latter of specimens of peat, lignite, and various kinds of soft and hard coal show very clearly the manner in which the presence of slate and other impurities can be determined.

Examinations of pieces in the lump can only be of a qualitative character, but a method devised by the author and by Dr. Aulich enables quantitative results to be obtained. For this purpose the sample must be ground to powder and a layer of standard thickness examined by X rays in comparison with a standard scale of comparison. The degree of opacity may then be made a measure of the impurity, and while the exact nature of the impurity cannot be obtained, the percentage of non-combustible can be measured with some degree of accuracy, although the method can only be regarded as an approximate one at the present time.

Herr Kotte's paper is accompanied with excellent reproductions of radiographs of various specimens, and further study in the application of the method may result in a greater degree of precision in its use.

The Steam Omnibus in Paris.

ALTHOUGH automobile vehicles have found a more rapid and general application in Paris than in any other city, yet the traction of omnibuses and tramway cars there is yet mostly performed by horses. This fact is mainly due to the objections which have prevented the introduction of overhead trolley wires, and to the expense accompanying underground traction or the use of accumulators.

The development of the steam automobile, however, has suggested the use of this motive power for tramway and omnibus service, and in a recent paper by M. G Mauclère in the *Revue Générale des Chemins de Fer,* an account is given of the vehicles now operated by the Compagnie Générale des Omnibus, using the Serpollet system of steam motive power.

M. Mauclère begins by giving a detailed description of the existing horse vehicles, the approved types, of which he gives drawings, bearing the dates 1874 and 1878, the latest of these having 21 places in the interior, 6 on the platform, and 24 on the imperial on the roof.

These vehicles are still in use on most of the lines, but on the routes St. Ouen-Bastille and Ivry-les Halles, the new steam vehicles have been placed.

The principal characteristics of the new omnibuses lie in the steam generator, which is of the well-known instantaneous type with which the name of M. Serpollet is associated. For this particular service the generator is arranged to be contained in a rectangular case lined with fire brick, the apparatus consisting of several varieties of the peculiar tubes used in this form of generator.

Above the grate there are placed three horizontal rows of tubes, the lower ones being cylindrical, with interior mandrels, leaving an annular space of but four millimetres in width for water, while above these are two rows of tubes of inverted U section, the water space in these being of the same width. In the chamber back of the fire-box there is a group of tubes, the first portion of which is composed of the annular tubes, behind which are some of the U section, and in the rear a double row of grouped tubes without contracted section, these latter being intended as collectors for the steam formed in the instantaneous generators. The whole consists of thirty-two elements connected by wrought-iron bends secured by forged nut collars, the connections being protected from the direct action of the fire. The whole boiler is contained in a space of 69 inches long, 38½ inches wide, and 49 inches high, and is placed in an enclosed space forming a portion of the front platform. The cylinders of the engine are placed in a sheet-iron case beneath the platform, the cranks being on an intermediate shaft carrying pinions engaging with gear wheels on the front shaft of the vehicle. Power is transmitted to the rear axle by chain gearing, so that both axles are driven by the one motor. The framework is built up of plate-iron and rolled sections, thus forming a very substantial base for the motive portion as well as a support for the body of the vehicle.

Apart from the general design of the omnibus, a few words may be given to the operation of the steam generator. As it is constructed to contain no water for a longer period than is necessary for the most rapid evaporation into steam, provision must be made for a feed supply in close proportion to the rate of evaporation, and as a continuous evaporation must be secured in order to maintain the pressure, the feed is arranged to be regulated by the variations in steam pressure. Two pumps are provided, one operated by hand, and used only when first starting the boiler, the other operated by power, and regulated automatically by the pressure. If, therefore, the fire is maintained, the pressure will control the injection of water into the highly heated tubes, and the very small capacity of these as compared with their heating surface will cause the water to be evaporated almost instantaneously, the generation of steam thus proceeding in proportion to the demands of the engine.

Boilers of this type have operated very successfully in connection with the steam automobiles bearing the name of M. Serpollet, and the advantage of avoiding the carrying of a boiler containing a large bulk of water is apparent for such service. Experience has demonstrated that the automatic regulation of the feed water is entirely practicable, and the number of vehicles now in operation is evidence that steam has not yet been crowded out of this field by either the electric or the internal combustion motor.

The Vibration of Ships.

The subject of the vibrations which occur in large and high-speed steamships has attracted increasing attention of late, and in the efforts to reduce such vibrations some very interesting investigations have been made. Most of these studies have had their origin in the application of the ingenious apparatus devised by Herr Otto Schlick, and described by him in a paper read at the Marine Congress at the Chicago Exposition in 1893. This apparatus, which consists of pendulums so arranged that the vertical and horizontal vibrations of a vessel are recorded upon a paper-covered drum, together with a series of second marks produced by clockwork, has done much to develop improvements in the method of balancing the reciprocating parts of marine engines.

As a result of the latest investigations upon this subject there appears a paper by naval constructor Berling in the *Zeitschrift des Vereines deutscher Ingenieure*, giving the results of experiments upon vessels of recent construction, together with some valuable deductions.

In considering the vibrations of vessels it must be remembered that a ship behaves in a similar manner to any elastic rod subjected to the action of disturbing forces, these latter tending to produce compression, extension, torsion, and bending, and that, within the limits of elasticity, the deformations are directly proportional to the forces by which they are produced. Since the hull of a ship, like any vibrating rod, has its normal period of vibration, due to its length and disposition of weight, it follows that the vibrations will be greatest in amplitude when the number of reciprocations of the moving masses approaches closely to the vibration period of the ship in a given unit of time. These vibrations may be of three different kinds: longitudinal, caused by compression and extension in the direction of the axis; transverse, due to bending action; and torsional, caused by the various twisting forces. The longitudinal vibrations are the least important of the three, and as the recording apparatus is not arranged to indicate motion in this direction these are not discussed; but the records of the horizontal and vertical motions at various points of a ship enable the transverse and torsional vibrations to be examined, both as regards period and magnitude.

The magnitude of these vibrations is much smaller than is generally supposed, being in ordinary cases only from 1 to 3 millimetres in amplitude. In one case noted by Herr Berling, however, the transverse vibrations reached 114 per minute, with an amplitude of 7 millimetres amidships and 21 to 24 millimetres at the ends, an action which was greatly reduced by a change in the pitch of the propeller.

Tests made with the recording apparatus at various points in a ship show that the hull is like a vibrating rod not only in having a definite time-period of vibration, but also in having nodes, or points of no vibration, and loops, or points of maximum vibration. These points being determined, it is evidently desirable that the machinery to which so much of the vibration is due, should be placed at one of the nodes, although, for constructive reasons, this is often impracticable.

So far as torsional vibration is concerned, there is usually little difficulty, since it is possible to make the hull very stiff in this direction, and modern designs are usually amply strong in this respect. The cause for such vibration is found in the twisting effort of the engines upon the propeller shaft, the rolling motion produced upon the ship at the section where the engines are placed being transmitted fore and aft in the form of vibrations. In the case of the loss of a propeller blade, an accident by no means uncommon, the unbalanced condition of the remaining portion adds much to the tremor, and sufficient rigidity to meet such an emergency should always be provided.

Although it is at present impossible altogether to prevent the production of vibrations, yet some of the efforts which have been made in this direction have shown the way to reduce very greatly the source of the most serious motion, *i. e.*, the action of the reciprocating masses of the engines. This subject, which is dealt with to some extent by Herr Berling, has been developed largely by the researches of Naval Constructor Taylor, of the United States Navy, and by Herr Otto Schlick of the German Navy, and the application of the arrangement of reciprocating parts indicated by them has been introduced into many large vessels, both in the navy and in the merchant marine. This method involves the determination, in a four-crank engine, of such crank angles as will cause the vibrations to oppose, and to a great extent neutralise each other, and in practice it has given excellent results, as the diagrams show.

In many cases vibrations may be materially reduced by a slight change in the number of revolutions of the engines, as the synchronism between the period of the machinery and that of the hull is thereby avoided. By changing the pitch or size of the propellers, a change in the speed of the engines is made practicable, and very often a great improvement may thus be made.

Doubtless the ideal method of avoiding vibrations from the steam machinery is the removal of all reciprocating motion, and in vessels of moderate size, at least, this may be accomplished by the use of the steam turbine. This involves the most careful balancing of all high-speed rotating parts, but the experience which has been had in this branch of applied mechanics in other lines should render accurate running balances entirely practicable, in which case the problem of vibrations so far as the engines are concerned, may be considered as solved.

Vertical Engines.

The general adoption of the vertical form for steam engines of large size is a matter which is well known, and indeed it is to the advantages of this form that a portion of the advance in steam engine economy during recent years has been attributed. The use of the vertical form, however, includes a number of problems, especially in connection with the framing and supports, which with the horizontal type practically took care of themselves, and hence a paper by Professor P. Straube, in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure,* dealing with this phase of the subject, is very timely.

For small vertical engines the usual cast iron column has shown itself to be well adapted, but for the large engines demanded by modern mill and power-house practice a built-up framework is necessary. In view of the general similarity in arrangement of working parts, many designers have simply adopted the precedents of marine engine practice, but experience has shown that the conditions are not altogether identical. In many cases opportunity is offered on shipboard for the bracing of the upper portion of the engine to the framing of the vessel, and twin-screw engines can be braced to each other, while in stationary practice the whole machine stands free and isolated.

Professor Straube first reviews the usual methods of framing vertical engines, and then takes up the actual nature of the forces to be resisted, both as to magnitude and direction, and shows how various designs may be made which will to a great extent meet and resist the stresses to advantage.

The ordinary framing, while well adapted to meet the vertical stresses due to the action of the reciprocating parts, is not always so well suited to withstand the lateral stresses caused by the action of the crank, connecting-rod and rotating masses. Some of these stresses are transmitted to the main shaft bearings, and as these are well supported in the lower portion of the engine, in close proximity to the foundation, they can be well met. Other forces are transmitted to the guides through the cross-head, and the manner in which the guides are supported therefore becomes a matter for careful consideration, while the point of attachment of the cylinder to the framing must always be regarded as a portion of the engine entering very critically into its stability.

When the framing is made wholly of cast iron a form somewhat like that adopted for heavy steam hammers has been used, but this does not permit ready accessibility to the moving parts, and in most instances but one side of the upright framing is made of a casting, this being used to carry the guides, while the other side of the cylinder is supported by wrought-iron rods. This construction, however, does not possess great lateral stability, and hence a number of arrangements are shown which enable diagonal bracing to be introduced, and some excellent forms of framing are given in which the cast-iron upright is omitted and the support composed wholly of wrought iron or steel rods, the inclined rods being firmly bolted to the base plate and to the cylinder with diagonals extending from the guides to the points of support above and below.

An important feature in this connection is the direction of rotation of the shaft. It is well known in horizontal-engine practice that when the engine runs "over" the pressure is downward on the guides, while when the engine runs "under" there is an upward lift. A similar action occurs in vertical engines, and as there is no especial resistance to either side by the base, the vertical framing should be so arranged as to meet the pressure upon the guides in the direction determined by the direction of rotation of the crank shaft.

In view of the extending use of vertical engines an examination of Herr Straube's paper by those engaged in engine design may be productive of more intelligent examples of frame construction than some which have been obtained by imitation of engines designed for an altogether different kind of service.

REVIEW OF THE AMERICAN PRESS

The Education of Machinists.

ONE of the most important papers presented before the recent convention of the American Society of Mechanical Engineers was that of Mr. M. P. Higgins, discussing the education of machinists, foremen, and mechanical engineers, viewed in the light of the writer's long and successful experience at the Worcester Polytechnic Institute.

It seems to be a generally accepted fact that the existing methods of practical technical education are not altogether satisfactory. The technical school turns out theoretical trained engineers, but is able to give only such a degree of practical shop work as will enable the student to have some very general ideas of the methods of actual work. The manual training school aims to train only the hand and the eye, and to give skill in the use of tools without attempting that scientific foundation for which no time is left.

Mr. Higgins proposes to answer the question: "How can we give our boys a chance to learn a *trade* without being deprived of a good common-school education and at the same time secure a foundation upon which to build a higher education if capacity and circumstances permit?"

He finds the answer in what he calls a "half-time school"; one in which a first-class machine shop is operated in connection with an academic department, half the time in a four years' course being spent in each department, the two courses being carried along in parallel, the time in each week being divided between them.

The paper elaborates upon the details of this idea, discussing the distribution of hours, the character of studies, and other matters of practical operation, based upon the experience at Worcester, but the key note of the whole paper lies in the idea that the training is to be given in an actual working shop, partly manned by regular mechanics, and making its products for the open market.

The interest which exists in the subject was clearly shown by the vigorous and effective discussion which the paper elicited from the members of the society. Rear Admiral Melville found the paper most stimulating to thought, but he was of opinion that it would be found impracticable to operate such educational works in competition with regular commercial establishments, and considered the best plan to be that of giving the boy as good an education as could be done up to the age of sixteen, making mathematics the leading subject, and then apprenticing him to the regular trade he elects to follow. Professor Hutton, on the contrary, thought the proposed method most excellent, and apparently saw no obstacle to the practical execution of the idea.

An excellent discussion presented by Professor Thurston gave a symposium of the views of a number of practical instructors consulted by him, and as might be expected, these included a wide variety of views. One of these, especially, appears to have struck the true key note of the situation, namely, the transformation which is now rapidly proceeding in the machinist's trade, a matter which appears to have been overlooked in the original paper. This was the opinion of Professor Kimball, who among other things, said:

"I do not believe that the manual skill required of the machinist is as high as that of thirty years ago. While some of the machines we now build are more complicated than any of that period, the tools furnished the workman are vastly superior to those in use at that time, so that the various portions of a complicated and delicate machine can be made more cheaply and easily and with less skill of the operator.

"For the same reason we have nearly obtained control of the world's markets. It is not so much the good management of our shops that has enabled us to do this, but it is the result of our great advance in machine-tool construction, whereby a man of little skill can turn out fine work in great quantities (turret-tools for example)."

As a matter of fact it is well known among managers of machine works that the best machinists do not always make the best foremen, and indeed there are some good reasons why they should not. The function of the foreman is executive, and while he should certainly be fairly well familiar with the details of the work of the men in his charge, it is the executive ability which is required to make his work successful. The best dramatic and musical critics are never drawn from the ranks of actors and performers, and indeed the opinions of these latter about their own work are notoriously defective.

So in the machine shop, the skilled mechanic who is made foreman usually wastes much of his time doing machinist's work himself, not because he wants to do so, but because he knows of no other way to get it done. The ability to direct and use men to the best advantage is a special talent, and one which is not apt to be developed by a close training of shop detail, but is rather found to result from a broad general training and a wider contact with men and methods than can possibly be acquired within the walls of any shop, however good.

The machine shop of the immediate future will contain a few highly skilled tool makers, specialized instrument makers, so to speak, caring for a shop full of special automatic tools tended by unskilled labor, the whole being under the supervision of an executive who must know men rather than machines, and who must be prepared to call for the technical skill of a few trained engineers to supply his own lack of manual training. For such a shop the technical school may be able to supply the men who make the tools and care for the machines, but these will be few in number. The machine tenders will require no shop experience, their work being limited to the mere starting and stopping, and the keeping the automatic machines supplied with material, and no trade school is needed to to supply such, while the engineers who design the tools and adapt the work to be produced by such automatic processes must come from the highest technical schools which can be had.

It must not be forgotten that the whole old-time machine shop, with its apprentices, journeymen, foremen, and the rest, is to a large extent a relic of mediævalism, bound to be supplanted by altogether different methods, as different from those which the trade school can teach as was the work of Gutenberg's press from the hand-work of the penman-monk who preceded him, and to agitate now any method of training general skilled machinists is as tardy as it would have been to endeavor to encourage the art of engrossing and illuminating when the printing press was already sweeping aside forever such primitive methods.

It is too late now to discuss any plans for manufacturing machinists by any process, however plausible; the turret lathe has supplanted the lathe-hand, the grinding machine the bench-fitter, while tools for handling, conveying, manipulating in every way have taken the place of nearly every kind of skill except the very highest and the very lowest, and the product of the training school cannot become the first and does not need his training to become the second. What he is to do is the great problem of the future, and this problem must be solved before any system of fitting him for it can be evolved.

The Equipment of a Railway Terminal.

There has probably been given no such conclusive evidence of the widening scope of the work of the mechanical engineer, as appears in the very full description of the mechanical equipment of the New South Station at Boston, Mass., contributed to the transactions of the American Society of Mechanical Engineers, by Mr. Walter C. Kerr.

Although this paper bears the name of Mr. Kerr, and was presented by him in person, yet he was most careful to state that the various portions of it were prepared by those engineers who had been respectively associated with the different sections of the work, the whole thus having a completeness not possible had it been produced by a single individual.

Although electricity is largely used in the various portions of this great plant, yet the electrical equipment forms but a small proportion of the entire work, and the whole is really what it has been termed by the authors of the paper, a mechanical plant.

Since this important paper fills more than a hundred closely printed pages, besides numerous illustrations, it is evident that any attempt to make a full abstract in the limited space here available is impossible. There are certain features, however, both in connection with the work and with methods by which it was executed, which call for interested comment.

The scope of the work will be realized when it is understood that the station is intended to accommodate 750 trains per day, and that the mechanical installation included the following items:

1. The complete installation of an electro-pneumatic system of switching and signalling.

2. A comprehensive power-house equipment.

3. An extensive electric wiring installation for arc and incandescent lighting, and for electric power for various uses.

4. Passenger and freight elevators, baggage and express lifts.

5. Apparatus for warming and ventilating the head house, and heating yard and express buildings.

6. Ice-making plant to supply ice for cars, restaurants, etc.

7. Refrigeration for restaurant, kitchen, and storage boxes, and flower booth.

8. Water filtering and cooling plant to furnish supply of drinking water.

9. Car heating in train shed, storage, and express yards.

10. Compressed air supply for charging and testing train brakes.

11. Fire protection for the various buildings and train shed roof.

12. Disposal of storm water and drainage from waterproofed structure.

13. Frost protection for roof conductors.

14. Steam and hot water supply for head house.

Instead of letting these diversified items to many separate contractors, it was decided to place the whole in the hands of a single firm of engineer-contractors, both with a view of securing an undivided responsibility, and also because this course appeared to offer many advantages as to unity of design and economy of execution. The satisfactory manner in which the work was accomplished will be understood when it is stated that the plant was started during the adverse conditions accompanying a great snow storm and that all portions operated successfully from the very start.

For the details of the various portions of the work the reader must be referred to the original paper, where will be found a much fuller description of details than is generally made public in such cases. The question for discussion here is that which was elicited at the time of the presentation of the paper, *i. e.*, the advantages and disadvantages of the method adopted.

The practice in such cases is radically different in England and in America. The consulting engineer, as the term is used in England, is but little known in the United States, the branch of the profession bearing that title being occupied mainly with expert advice in legal questions with municipal problems, and with advisory matters generally. In England such an undertaking would probably have been placed in the hands of a consulting engineer, by whom fully detailed plans would have been prepared, to which plans all contractors would have been obliged to conform, the work being subjected to rigid inspection as it progressed.

In the United States, on the contrary, the whole was turned over to a single firm, both for design and execution, with full liberty as to the methods employed and correspondingly full responsibility as to results attained.

The outcome was an entirely satisfactory performance within the limited time available, and at a greatly reduced cost over what could have been obtained under the older method of working.

Assuming an entire responsibility and honesty on the part of the undertakers, the reasons for the attainment of the above results will be apparent. Instead of requiring everything to be constructed from new designs, involving all the expense of patterns, drawings and special costs, standard devices were used where possible, and the experience of specialists in all the various lines thus made available. All the advantages of standardizing were thus obtained, while the single control enabled all these interests to be utilized without conflict.

It is a question whether such a method could be introduced into England with success, but already the questions involved in the American method of doing things have been made the subject of animated discussion, and the difference in methods between the two countries has been held in some quarters to be largely responsible for the success with which America has entered into competition with England in all parts of the world. Viewed in this light, this paper will doubtless receive much attention on both sides of the Atlantic, as the fullest detailed account of the American method, carried to extreme limits on a very large scale, which has yet been given to the public.

Fly Wheels and Shafts.

One of the features of the discussion about the Glasgow tramway engines was that of the large shafts and heavy fly-wheels in the proposed American designs, and now a communication upon the same points appears in the *American Machinist* from the pen of Mr. W. H. Booth, which elicits comment.

Mr. Booth notes the curious change in opinion concerning engine speeds both in England and America. It was not so very long ago that America was regarded as the home of high-speed engines, while in England the precedent of the old beam engine kept down speeds of rotation. Now all this seems to have changed. English engines are of high rotative speeds, and it is only American engineers who specify slow speeds. Thus the Glasgow engines, over which there has been quite a little fuss, are intended to run at a speed of only 75 revolutions a minute, with a stroke of 5 feet, this being only about half the speed of some marine engines of similar character.

This slow speed has been accompanied with the use of very heavy fly-wheels, and what have been criticised as being excessively large shafts, the diameter in some cases being double what would correspond with current marine practice, notwithstanding the sudden and heavy stresses to which marine-engine shafts are subjected.

Assuming that these large diameters are intended to resist the sudden stresses due to quick changes in load in electric tramway service, Mr. Booth proceeds to show that the maximum stress in an engine is that due to the full boiler-pressure exerted upon the piston at the dead points, and maintains that every well-designed engine is intended to withstand such stresses. He then explains that by placing the generator-armature on the same end of the shaft as the fly-wheel the severe stresses are isolated from the engine and confined to the short straight portion of shaft between the armature and the fly-wheel.

The opinion in England is that the stresses in traction work have been much overrated, and that as the exchange of energy between fly-wheel and armature is not absolutely instantaneous, the stresses upon the shaft are not excessive. Still it is admitted that an allowance requires to be made for the excess of stress produced by even moderately sudden accessions of load.

Mr. Booth suggests that such stresses may be entirely eliminated by making the fly-wheel a part of the generator in a manner similar to that already employed in the construction of alternating-current generators.

As a matter of fact the question of these stresses has had but little to do with the proportions adopted by the leading American builders of engines for traction power-house service. As will be seen by reference to the illustrations of the engines for the power house of the Metropolitan Traction Company of New York, as shown in another portion of this issue, the armature, while carried on the shaft, is driven by direct connection to the body of the fly-wheel, so that the stresses of rotation only reach the shaft after passing through the fly-wheel, and the suddenness of their changes need not affect the shaft at all.

The real reasons for the adopted dimensions of shaft are altogether different from those assumed by Mr. Booth, being, in the first place, to provide such ample projected journal-bearing area as to reduce the unit pressure to a very moderate amount, and, second, in consequence, to reduce the wear upon the journal bearings to such a very small amount as to prevent appreciable settling of the armature with respect to the field. It is of much importance to insure the concentric position of armature and field in the first erection of the machine, since the magnetic balance thus secured is desired, while the only manner in which this relation can be maintained is by providing what might otherwise appear to be excessive dimension for the journal bearings.

It must not be forgotten that the change of practice in America from small high-speed engines to large, heavy, slow-speed ones, has not been caused by the efforts of any especial class of constructors and engineers, but has been a growth due to the demands of experience in that country in which, up to the present time, electric traction has been developed to an extent far exceeding that of all other portions of the world together. Under such conditions it ought not to be difficult to ascertain the causes for the adoption of existing designs nor the reasons for their continuance.

The Albany Filtration Plant.

In view of the active interest which is being taken both in Europe and America in regard to the question of providing pure water supply to cities, the paper of Mr. Allen Hazen, contributed to the Proceedings of the American Society of Civil Engineers, describing the Albany filter plant, is an important contribution to the practical side of the question.

The city of Albany has of late been supplied with water from the Hudson river, notwithstanding the fact that the drainage from many large towns above polluted the stream and a portion of the sewage of the city itself, under certain conditions, found its way into the intake. Under such circumstances it is not a matter for surprise that the typhoid fever death-rate in the city became excessive, and various attempts were made to secure an unpolluted supply. Inability to succeed in these attempts led to the decision to continue the use of Hudson water, removing the intake to a point somewhat further above the city, and installing slow sand filters to remove the bacteria which cause disease.

In July, 1897, the preparation of plans for the filters was begun, and the completed plant is now in successful operation. The plant consists of a sedimentation basin 383 feet by 600 feet in area, from which the water flows to eight vaulted filter beds, each 121 by 258 feet in area. The object of covering the filters was to protect them from the weather, it being quite cold in Albany during the winter, and the entire construction is of masonry, the piers, cross-walls, and linings of the outside walls being of vitrified brick, and all the other masonry being of concrete. Inverted groined concrete arches are used to form the floors, and the roofs are of concrete vaulting, of 12 feet span. The vaulting is covered with 2 feet of earth, grassed on top, the drainage from this soil being delivered into the filter beds and allowed to pass through with the river water.

The drains beneath the floors were put in before the construction of the latter was begun, and thus no break in the inverted arches was necessary. The construction of these underdrains is an important matter, as it is necessary to provide sufficient capacity to reduce the resistance to a minimum and at the same time cause the pull upon the remote parts of the filter to be as nearly as possible equal to that at the points near the outlet.

The bottoms of the beds are covered with gravel, three sizes being used. The coarsest is in sizes between 1 and 2 inches, this being used to surround the pipe drains and to cover a portion of the floor. The intermediate grade, of sizes between 1 inch and ⅜ inch, is used in a layer of about 2 inches thick, and above this is a layer of finer gravel in sizes between ⅜ and 3-16 inch, to a depth of 2½ inches. Above this comes the actual filtering bed of river sand, 4 feet in depth, the sand being selected so as to be free from organic matter, clay, and lime, the latter being found objectionable in that it acts to harden the water.

The area of each filter bed is 0.7 acre, each filter having a capacity of 2,100,000 gallons daily, and as one filter is always undergoing cleaning, the capacity of the plant with seven filters in operation is 14,700,000 gallons per day. This is a nominal rate which may be exceeded upon demand, the intake, pumping station, and piping being proportioned for a maximum capacity of 25,000,000 gallons per day.

The paper contains many detailed illustrations describing the construction of the plant more fully than is possible in this limited space, and in addition to the construction, illustrations are given of the sand-washing apparatus, a system of successive water jets being employed for this purpose.

It is interesting to note that this large filter plant has operated most successfully from the start. Mr. Hazen says: "The filters were designed to remove from the water the bacteria which can cause disease. They have already reached a bacterial efficiency of over 99 per cent., and it is expected that their use will result in a great reduction in the death rate from water-borne disease in the city. They also remove a part of the color and all of the suspended matters and turbidity, so that the water is satisfactory in its physical properties. The filters have reached with perfect ease their rated capacity, and on several occasions have been operated to deliver one-third more than this amount; that is to say, at a rate of 4,000,000 gallons per acre daily."

The total cost of this important work was about $500,000, or more precisely $496,633, of which about $325,000 was for the actual construction, the remainder being for land, pumps, piping and engineering expenses. The original estimate was $478,000, so that the actual cost exceeded the estimate by only about 4 per cent.

Naval Engineering in America.

The Presidential address by Rear-Admiral George W. Melville at the recent convention of the American Society of Mechanical Engineers contained much interesting matter concerning the development of naval engineering in America, and the close relation which Mr. Melville has had with much of this development, by virtue of his position of Engineer-in-Chief for many years, renders anything he has to say of especial interest.

After calling attention to the fact that Fulton not only developed steam navigation in general, but also constructed the first steam war vessel in the world, he reminded his hearers that the first chief of the engineer corps, Mr. Charles H. Haswell, was appointed as long ago as 1836, and is yet living, although his service as chief engineer began before Queen Victoria ascended the throne.

Mr. Melville took occasion in the course of his address to pay a well-merited tribute to the energy and ability of Chief Engineer B. F. Isherwood, and the time and place made his remarks in this connection most appropriate. Mr. Isherwood developed the scientific side of the work of the department of steam engineering in a manner which added greatly to its reputation, but at the same time he received much adverse criticism, and the great value of his work is only gradually being recognized. Experiments upon the properties of steam were made by him on a larger scale than had hitherto been attempted anywhere, and as a result the influence of cylinder condensation, the great problem which confronts the steam engineer to-day, began to receive consideration. His designs for engines, although criticised for their weight and massiveness, were admirably adapted to the hard service required of them during the Civil War, and in the Wampanoag, for both the engines and hull of which Mr. Isherwood was responsible, is found the prototype of the modern swift cruiser, her speed being at least 4 knots higher than any ship of her time; and this was demonstrated in a 37 hour run in rough weather off Cape Hatteras.

In reviewing the progress made in naval engineering in the United States, Mr. Melville named many engineers who received their training at the Naval Academy and did good work in the service, and then retired to take part in private practice or to connect themselves with educational institutions. Two of his predecessors in the office of President of the American Society of Mechanical Engineers, were engineers in the Navy, one being Dr. Thurston and the other Dr. E. D. Leavitt, the former having been a class-mate of Mr. Melville himself, while among other prominent engineers who have contributed to the development of engineering in America and who began in the engineer corps may be named the late Charles E. Emery, George Westinghouse, and Theodore Cooper.

Admiral Melville gave a summary of the present condition of engineering practice in the Bureau of Steam Engineering, much of which corresponds to the matter in his recent annual report, reviewed in these columns last month, and there is every reason to feel, from the manner in which the steam engineering portion of the work of the navy has been done, that practice in the United States is fully abreast with that of any other country.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly. *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison. U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Bank Building.

The Buffalo Savings Bank. Illustrated description of a banking building containing two domes, one above the other, pendentive ceilings and other special features, including heating arrangements. 4000 w. Eng Rec—Nov. 25, 1899. No. 30954.

Bricklaying.

Practical Bricklaying. Owen B. Maginnis. Part first explains the tools and appliances used, and the attitudes and actions of the bricklayer. 1100 w. Arch & Build—Nov., 1899. Serial. 1st part. No. 30608.

Convention Hall.

The Convention Hall at Kansas City, Missouri. A two-page plate, with description of a building with a seating capacity of 25,000, representing an investment of $240,000. 1800 w. Eng News—Nov. 2, 1899. No. 30686.

Dewey Arch.

The Material for the Permanent Dewey Arch. Extract from an article by Russell Sturgis, in the *N. Y. Evening Post,* discussing this subject. 2500 w. Stone—Oct., 1899. No. 30570 C.

Fireproofing.

A New Form of Hollow Tile Fire-Proof Floor Arch Construction. Illustration, with description of the invention of Henry L. Hinton, called the serrated arch. 1300 w. Eng News—Nov. 9, 1899. No. 30702.

Recent Fire Tests of Fireproofing by the British Fire Prevention Committee. Gives details of a comparative fire test of two different constructions of fireproof doors. 1600 w. Eng News—Nov. 9, 1899. No. 30701.

Foundations.

Foundations for Buildings. Henry W. Hodge. Ideas of what should and should not be done, with descriptive examples. Ill. 3000 w. Br Build—Nov., 1899. No. 31108 C.

Framing.

An Unusual Framed Building. Illustrated description of a building with sides and roof supported by a single truss system like an arch. 700 w. Eng Rec—Nov. 18, 1899. No. 30842.

Handling.

Lifting a 24-Ton Girder Four Stories. Describes a difficult undertaking carried out during one night when the streets were free from traffic. 1000 w. Eng Rec—Nov. 11, 1899. No. 30715.

N. Y. Capitol.

The New York Capitol Building. Cuyler Reynolds. Historical account of this edifice, which has cost nearly thirty million dollars, illustrating many parts, describing and criticising the work. 5000 w. Arch Rec—Oct.-Dec., 1899. No. 30730 C.

Public Baths.

The Sutro Baths, San Francisco. Describes the structural features of a large bathing establishment on a terrace quarried out of the face of a cliff. 900 w. Eng Rec—Nov. 11, 1899. No. 30717.

Public Library.

A Public Library, to Cost One Hundred Thousand Dollars. Thomas M. Kellogg. The first of a series of articles illustrative of a library building, and showing the possibilities of brick architecture. Ill. 1500 w. Br Build—Nov., 1899. Serial. 1st part. No. 31107 C.

The Washington Public Library. Illustrated description of the general arrangement of the Carnegie library. 1800 w. Eng Rec—Nov. 11, 1899. No, 30716.

Roof Trusses.

Pin and Riveted Roof Trusses. Editorial discussion of the relative merits of the two classes. 900 w. Eng Rec—Nov. 11, 1899. No. 30703.

Stairs.

The Construction of Circular Stairs and Spiral Vaults. Lawrence Harvey. Read before the British Arch. Assn. An account of the origin of this form of stairway, with some hints on the construction. 1500 w. Brit Arch—Nov. 3, 1899. No. 30754 A.

Steel-Cage Construction.

Wall Supports in a Steel Cage Building. Illustrated description of the characteristic steel-cage details in a 16-story building for offices and light manufacturing. The Vincent Building, New York. 1000 w. Eng Rec—Nov. 4, 1899. No. 30654.

Stone.

Color and Decay of Stone. First article on "The Building Stones of Wisconsin," reviewing a recently issued volume by Ernest Robinson Buckley. 4000 w. Stone—Oct., 1899. Serial. 1st part. No. 30568 C.

Limestones and Marbles of Alabama. Information concerning stones for building, paving, curbing, etc. 2500 w. Stone—Oct., 1899. No. 30569 C.

Stone in American Architecture. Russell Sturgis. Interesting illustrated discussion of the use of various stones as a material, stone-working, etc. 10,000 w. Arch Rec—Oct.-Dec., 1899. No. 30731 C.

The Return to Stone. W. S. Adams. On the increase in favor recently shown for this material. Ill. 1200 w. Arch Rec—Oct.-Dec., 1899. No. 30732 C.

Use of Oolitic Stone in England. Extract from article published in the *Stone Mason,* of Bristol, Eng. Concerning the use of this stone and its weathering properties. 600 w. Stone—Nov., 1899. No. 31110 C.

Tiles.

Manufacture of Tiles in Foreign Countries. Consular reports concerning this industry from the various countries. 8300 w. U. S. Cons Repts. No. 581—Nov. 16, 1899. No. 30791 D.

HEATING AND VENTILATION.

Bank Building.

A Hot-Blast Gravity Steam-Heating Apparatus. Illustrated description of a system of heating and ventilation installed in a Utica bank building, an unusual feature of the work being the provision for the ventilation of many of the offices leased to tenants. 1500 w. Eng Rec—Nov. 4, 1899. No. 30655.

Dust Removal.

Sanitation of Establishments Used for Color Printing (Assainissement des Locaux Destinés à l'Impression à l'Aide des Couleurs en Feuilles). J. Carlioz. A discussion of the unhealthfulness of color printing by the "dusting on" processes, with illustrations showing methods of arranging exhaust ventilating fans for the removal of the dust. 1800 w. Génie Civil—Nov. 4, 1899 No. 31006 D

Heating Surface.

Heating Surface: Its Best Form and Relation to Radiating Surface. John Kitchen. Read before the British Inst. of Heat. and Ven. Engs. The necessity of understanding the conditions to be fulfilled, in order to reach correct conclusions. Discusses different systems and experiments. 3500 w. Plumb & Dec—Nov. 1, 1899. No. 30771 A.

Radiation.

Radiating Surface. Earnest T. Child. A comparison of the methods of determining the proper amount of radiating surface. 2200 w. Met Work—Nov. 11, 1899. No. 30682.

Ventilation.

Ventilation in Its Relation to Heating, etc. W. R. Maguire. Read before the British Inst. of Heat and Ven. Engs. Discusses some of the systems in use, and points worthy of attention. 5000 w. Plumb & Dec—Nov. 1, 1899. No. 30-770 A.

PLUMBING AND GAS FITTING.

Drainage.

House Drainage as It May Be. The first of a series of articles on house drainage. Ill. 1300 w. Dom Engng—Nov., 1899. Serial. 1st part. No. 30846 C.

Fittings.

Sound Gas Fittings. Norton H. Humphreys. The importance of seeing that all fittings are gas tight. 2000 w. Jour Gas Lgt—Nov. 7, 1899. No. 30-794 A.

Suburban.

Suburban Gas Lighting. Describes work in a suburban dwelling, of unusual excellence. 2000 w. Dom Engng—Nov., 1899. No. 30847 C.

MISCELLANY.

Address.

Presidential Address Before the Royal Institute of British Architects. William Emerson. A review of the architecture and architects of the past century. 9000 w. Builder—Nov. 11, 1899. No. 30853 A.

Architectural Practice.

English and American Architectural Practice. R. Clipston Sturgis. A comparison of the present conditions of practice in these two countries. 4500 w. Arch Rev—Nov., 1899. No. 30960 D.

Brasses.

Monumental Brasses. G. H. Smith. Read before the British Architectural Assn. Interesting information concerning the development of brasses. Ill. 2000 w. Builder—Nov. 11, 1899. No. 30854 A.

Estimates.

Quantity Bids on Architectural and Engineering Contracts. G. A. Wright. A description of the methods in vogue in many countries and made obligatory by law in some, by which contracting for works is made less of a gamble than under lump sum bids. 3300 w. Eng Rec—Nov. 4, 1899. No. 30656.

Stained Glass.

Domestic Stained Glass in France. René de Cuers. Concerning the present state of the stained-glass window manufacture in general and of domestic stained-glass windows in particular, describing effects and results. Ill. 5500 w. Arch Rec—Oct.-Dec., 1899. No. 30729 C.

CIVIL ENGINEERING

BRIDGES.

Albany.

New York Central Improvements at Albany. An illustrated account of the reconstruction of the Hudson River passenger bridge. 1000 w. R R Gaz—Nov. 10, 1899. No. 30736.

Algiers.

The Construction of the Bridge of Oued Endja, Algeria (La Construction du Pont de L'Oued Endja). A. Daujon. The official report, with full description of the sinking of the pier caisson, and the construction and launching of the girders. An important work in the French-African colony. 15000 w. 1 plate. Ann des Ponts et Chausées—2 Trimestre, 1899. No. 31079 E + F.

Arch.

The Statical Investigation of Arches (Beitrag zur Statischen Untersuchung von Gewölben). M. Marcus. A graphical analysis of the statical reactions in voussoir arches, using the polar diagram and force polygon. 1200 w. Schweizerische Bauzeitung—Oct. 21, 1899. No. 31-045 B.

Atbara.

The Atbara Bridge. Illustrated description of the bridge and its erection, the story of the foreman who had charge of its transportation and erection, and Lord Kitchener's speech at its dedication. 4500 w. Eng Rec—Nov. 4, 1899. No. 30650.

Bracing.

The Location of Diagonal Members in Parallel Lattice Girders (Ueber das Centrieren der Diagonalen in Parallel-Gitterträgern). L. Nicolay. A mathematical examination of the conditions obtaining in lattice girders which show the most economical positions for diagonal members. 1000 w. Schweizerische Bauzeitung—Oct. 28, 1899. No. 31047 B.

Ceylon.

Bridge Erection in Ceylon. Describes methods of renewing a bridge without employing falsework. 600 w. Eng Rec—Nov. 11, 1899. No. 30718.

Counter Stresses.

Insufficient Provision for Counter-Stresses in Railroad Bridges. Discussion of paper by Henry S. Pritchard. 1700 w. Pro Am Soc of Civ Engs—Nov., 1899. No. 30936 E.

Deflections.

An Instrument for Measuring and Recording Bridge Deflections. Illustrates and describes an apparatus devised by B. F. Pickering. 700 w. Ry & Engng Rev—Nov. 11, 1899. No. 30748.

France.

Proposed Bridge Across the Rance, France. Information concerning this bridge, stating the conditions to be satisfied. 1000 w. U. S. Cons Repts, No. 568—Nov. 1, 1899. No. 30564 D.

Highway.

The Snake River Bridge. Illustrated description of a cantilever highway bridge having rocker bents under the cantilevers and inclined anchor arms. 2500 w. Eng Rec—Nov. 18, 1899. No. 30835.

Piers.

Concrete Piers, Sangamon River Bridge. Illustrates and describes the method of building some massive concrete piers, the method of doing the work being prescribed by the engineer and not left to the contractor. 600 w. Eng Rec—Nov. 4, 1899. No. 30651.

Plate-Girder.

New Form of Plate-Girder Swing Bridge, C. M., & St. P. Ry. Illustrated description of a bridge of somewhat novel design, made to take the place of a wooden span 161 ft. long, swinging upon a center pier. The conditions were unusual, owing to a proposed improvement of the river channel. 1000 w. Ry & Engng Rev—Oct. 28, 1899. No. 30536.

Rouen.

The New Bridge at Rouen. From *La Nature*. Illustrated description of a transshipping bridge. 900 w. Sci Am Sup—Dec. 2, 1899. No. 31117.

Steel Bridge.

The Delaware River Bridge at Bridesburg. Illustrated description of the details of a structure with both plate-girder and large truss spans. 2800 w. Eng Rec—Nov. 25, 1899. No. 30947.

Stresses.

Statically Indeterminate Structures. An editorial on the need of members which make a structure statically indeterminate. 1100 w. Eng Rec—Nov. 4, 1899. No. 30648.

Suspension.

The Cables and Suspenders for the New East River Bridge, New York City. Illustrates and describes the general details for the center suspension span. 2700 w. Eng News—Nov. 23, 1899. No. 30911.

The Latest Suspension Cable Specifications. The requirements for the steel wire and workmanship for the four cables of the new East River bridge, New York. 2000 w. Eng Rec—Nov. 18, 1899. No. 30836.

The New East River Bridge. Gives specifications for steel cables, suspenders, coverings, sheaves, bands, and their appurtenances. Ill. 2500 w. Ir Age—Nov. 16, 1899. No. 30782.

The New East River Bridge. Illustrated description of some details of the parts to be contracted for. 700 w. R R Gaz—Nov. 24, 1899. No. 30942.

The Stiffened Suspension Bridge. An editorial discussion of the field of usefulness of this type and of the methods of designing the stiffening truss. 1100 w. Eng Rec—Nov. 18, 1899. No. 30834.

Viaduct.

Redecking a Viaduct. Illustrated description of the method of renewing a highway bridge floor. 400 w. Eng Rec—Nov. 11, 1899. No. 30711.

Widening.

Widening a Washington Highway Bridge. Describes the addition of cantilever brackets for side walks, to a plate-girder skew bridge. 700 w. Eng Rec—Nov. 11, 1899. No. 30712.

CONSTRUCTION.

Breakwaters.

The Reaction Breakwater as Applied to the Improvement of Ocean Bars. Discussion of the paper by Lewis M. Haupt. 20000 w. Pro Am Soc of Civ Engs—Nov., 1899. No. 30937 E.

The 3000-Ton Concrete Blocks and Rolling Caissons at the Bruges Ship Canal, Belgium. Abstract from paper of L. V. Vernon-Harcourt, read before the Inst. of Civ. Engs. Describes the method of making these monoliths of concrete, which weigh from 2500 to 3000 tons. 1200 w. Eng News—Nov. 9, 1899. No. 30696.

Dam.

Proposed Design for a Steel and Concrete Dam. John S. Fielding. Illustrates and describes a truss design, discussing its advantages. 2200 w. Eng News—Nov. 16, 1899. No. 30798.

Rock Dams with Metallic Reinforcement (Barrages-Réservoirs en Remblai Rocheux). A. Dumas. With illustrations of important reservoir-dams in California, constructed with sheet-iron core, and stone embankment. 3000 w. Génie Civil—Oct. 21, 1899. No. 31001 D.

Estimates.

See Architectural Engineering, Miscellany.

Foundations.

See Architectural Engineering, Construction.

Highway.

State Aid Roads in New Jersey. C. E. McDowell. Information concerning the roads started or completed. 3000 w. Stone—Oct., 1899. No. 30567 C.

The Karlstädt Imperial Road Between Jugorje and Möttling (Die Umlegung der Karlstädter Reichsstrasse zwischen Jugorje und Möttling). Karl Grünhut. With topographical map, and profiles, together with tables showing the influence of grades on the cost of transport. 4000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1899. No. 31-038 D.

The Maintenance of Highways. A review of recent advice by the State Engineer of New York. 1800 w. Eng Rec—Nov. 18, 1899. No. 30838.

Pier.

Landing Pier at Pauillac (Appontement de Pauillac, Gironde). Ch. Talausier. Illustrated description of the new pier on the Gironde, forming a deep-sea port for the city of Bordeaux. Serial, Part I. 2500 w. 1 plate. Génie Civil—Nov. 4, 1899. No. 31004 D.

Piers.

See Bridges.

Pile-Drivers.

Two Railway Pile-Drivers. Illustrates and describes the machine designed by G. W. Smith, giving extracts from his paper in the *Jour. of W. Soc. of Engs.* Also another pile-driver built for the G., C., & S. F. Ry. 2400 w. Eng News—Nov. 16, 1899. No. 30796.

Roof Trusses.

See Architectural Engineering, Construction.

Tunnel.

The North Bessemer Tunnel. Describes the driving of a tunnel 2900 ft. long for a double-track railway. 600 w. Eng Rec—Nov. 11, 1899. No. 30719.

HYDRAULIC AND MARINE.

Bar.

The Bar at Rio Grande do Sul (La Barra de Rio Grande do Sul). L. L. Vauthier. An account of the works for the maintenance of a permanent channel at the mouth of the canal connecting the port of San Pedro, Brazil, with the ocean. 8000 w. Ann des Ponts et Chaussées—2 Trimestre, 1899. No. 31-082 E + F.

Canals.

The Canal Problem in New York: A New Solution. A reprint of editorial in the *Journal of Commerce.* Suggests the building upon the banks of the Erie Canal a double-track railway for freight traffic only. 3500 w. Eng News—Nov. 9, 1899. No. 30698.

The Canal System of Canada. Describes the improvements recently made, which will make it possible for vessels drawing 14 ft. to steam from Lake Superior to the sea. 2000 w. Engr, Lond—Nov. 3, 1899. No. 30757 A.

The Dortmund-Ems Canal. A brief account of this important waterway. Ill. 1200 w. Engr, Lond—Nov. 17, 1899. No. 30996 A.

The Transformation of the Lateral Canal of the Loire (Transformation du Canal Latéral à la Loire). M. Mazoyer. A full account of the improvement works, with illustrations of the aqueducts, bridges, and masonry details. 18000 w. 3 plates. Ann des Ponts et Chausées—2 Trimestre, 1899. No. 31081 E + F.

Cisterns.

Cisterns: Their Use and Necessity with Constant Water Supply. Ernest Collins. Read at the Congress of the Sanitary Inst. Discusses the need of reservoir cisterns, their care, and the best systems. 2200 w. Plumb & Dec—Nov. 1, 1899. No. 30769 A.

Drainage.

The Drainage of the Pinsk District, Russia (Trockenlegung der Sümpfe in Polesie). With a very complete map, showing the existing canalisation of the district, and the projected improvements for the drainage of this marshy district of western Russia. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1899. No. 31039 D.

The Drainage Works of New Orleans. Illustrated description of the open and closed canals for surface drainage. 2000 w. Eng Rec—Nov. 11, 1899. No. 30708.

The Electric Drainage of New Orleans. Lyman C. Reed. A statement of the conditions and an illustrated detailed description of the plant. 4400 w. Elec Wld & Engr—Nov. 18, 1899. No. 30809.

The Main Drainage of London. Extracts from the report of the Main Drainage Committee of the London County Council, with comments. 4500 w. Engr, Lond—Nov. 10, 1899. No. 30864 A.

The Main Drainage of Ottawa. Illustrated description of the details of a system of difficult river crossings. 1800 w. Eng Rec—Nov. 25, 1899. No. 30951.

Driven Wells.

Driven Wells and Their Proper Treatment. Jas. R. Maxwell. Read at the convention of the Central States Water Works Assn., Cincinnati, Ohio. Gives suggestions derived from long experience. 1000 w. Fire & Water—Nov. 11, 1899. No. 30741.

Dry Dock.

Hydraulic Lifting Dry Dock at Union Iron Works, San Francisco. Illustrated detailed description. 1500 w. Marine Engng—Nov., 1899. No. 30610 C.

Filtration.

An Automatic Controller or Regulating-Weir. Illustrated description of an apparatus enabling a mechanical filter to be regulated with unusual closeness. 800 w. Eng Rec—Nov. 25, 1899. No. 30948.

Bacterial Test of a Mechanical Filter at Louisiana, Mo. Gives results of a filter which is treating water drawn from the Mississippi River. Ill. 1800 w. Eng News—Nov. 16, 1899. No. 30799.

Recent Experience with the Lawrence Filter. A description of the clogging of part of an open sand filter and the method of repairing the trouble, which was in the under drains. 2000 w. Eng Rec—Nov. 25, 1899. No. 30949.

The Albany Water Filtration Plant. Allen Hazen. Gives an historical account of the supply, a description of the plant, and information relating to its operation and construction. Ill. 13600 w. Pro Am Soc of Civ Engs—Nov., 1899. No. 30935 E.

Leakage.

The Leakage from Street Mains. Summary of investigations made by J. J. R. Croes, in New York, showing that the leakage from old pipes is much greater than is usually supposed. 1000 w. Eng Rec—Nov. 4, 1899. No. 30657.

Locks.

Locks and Lock Gates for Ship Canals. Henry Goldmark. A detailed discussion of their construction and operation, with historical review. 7000 w. Jour Assn of Engng Socs—Sept., 1899. No. 30-566 C.

Nile.

The Engineering Control of the Nile. Considers the means which have been and are to be adopted for the control of this river. 3500 w. Builder—Oct. 21, 1899. Serial. 1st part. No. 30535 A.

Utilization of the Nile. An illustrated description of the finally sanctioned design of the dam at Assouan and the barrage at Assiout. 1800 w. Engr, Lond—Nov. 3, 1899. No. 30758 A.

Oder.

The Harbor of Cosel on the Oder, and its Present Commerce (Der Oder-Hafen zu Cosel und sein Bisheriger Verkehr). J. Riedel. An account of the important internal commerce centering at Cosel on the canalised Oder, near Breslau. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 10, 1899. No. 31021 B.

Pipe Incrustation.

The Incrustation of Iron Pipes at the Torquay Water Works. William Ing-ham. Read before the Inst. of Mech. Engs. Illustrates and describes the pipe scrapers used, also the condition of the pipes, and the results. 4000 w. Engng—Nov. 3, 1899. No. 30752 A.

Reservoirs.

Covered Reservoirs. Frank L. Fuller. Illustrates and describes reservoirs from the writer's designs. 3800 w. Jour Assn of Engng Socs—Sept., 1899. No. 30565 C.

Rhine.

The Regulation and Information Service on the Rhine in the Vorarlberg (Der Wasserwehr und Nachrichtendienst am Rhein in Vovarlberg). An account of the methods used for regulating the upper Rhine; also the telephone service for communicating warnings of sudden freshets. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1899. No. 31040 D.

Scour.

Dangerous Scour Caused by Bridge Piers. A note on the effect of piers in the Gatinean River, Canada, and the remedy. 600 w. Eng Rec—Nov. 11, 1899. No. 30710.

Storage Reservoirs.

Surveys of Sites for Irrigation Storage Reservoirs by the U. S. Geological Survey. A statement relating to water storage, proposed by F. H. Newell, of the Div. of Hydrography of the U. S. Geol. Surv. 1500 w. Eng News—Nov. 23, 1899. No. 30912.

Streams.

Stream Measuring in the United States. F. H. Newell. Introduction of a report for 1897, reprinted from the U. S. Geological Survey annual report. Ill. 2200 w. Sci Am Sup—Nov. 11, 1899. Serial. 1st part. No. 30680.

Water Rights.

Public and Private Rights in River Water. The decision of an Illinois court concerning the right of Elgin to take water from a mill-pond. 2800 w. Eng Rec—Nov. 18, 1899. No. 30839.

Water Supply.

New York's Water Supply. Peter Milne. Gives the writer's opinions concerning some points mentioned in paper of J. J. R. Croes, and calls attention to other facts. 1800 w. Fire & Water—Nov. 18, 1899. No. 30845.

Summary of the Report of the Commission on the Extension and Improvement of the Water Supply of the City of Philadelphia. 5000 w. Jour Fr Inst—Nov., 1899. No. 30606 D.

The Increase of Water Consumption. Editorial comment on this subject. 1400 w. Fire & Water—Nov. 4, 1899. No. 30667.

The London Water Question. Editorial discussion of matters relating to the proposed supply. 3300 w. Builder—Nov. 11, 1899. No. 30852 A.

The Water Supply of Manhattan and the Bronx Boroughs. Extracts from the report of J. J. R. Croes, and from a letter of Dr. P. Sherwood Dunn. 2500 w. Fire & Water—Nov. 11, 1899. No. 30740.

The Water Supply Question in Bavaria (Der Stand der Wasserversorgung in Bayern). With especial reference to the water-bearing strata beneath Munich and the surrounding country. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 4, 1899. No. 31035 D.

Water-Works.

A Lesson in Water-Works Management. Illustrated article showing the economy with which the New York water works were managed whenever the commissioner was able to understand engineering reports and the waste which occurred at all other times. 800 w. Eng Rec—Nov. 11, 1899. No. 30705.

Turkish Syphons at Constantinople. Edward Wegmann. Illustrated description of the souterazi which the Turks consider necessary for the successful operation of a long water main. 700 w. Eng Rec—Nov. 11, 1899. No. 30707.

Water-Works Expansion in Boston. J. A. Stewart. Illustrates and describes interesting work in carrying out the plans of the Metropolitan Water Board. 2400 w. Sci Am—Nov. 4, 1899. No. 30582.

Water-Works in Panama. Printed translation of the invitation for bids to build the aqueduct to supply the city with water. 3800 w. U. S. Cons Repts, No. 580—Nov. 15, 1899. No. 30780 D.

MATERIALS.

Asphalts.

The Physical Properties of Asphalts and Asphaltic Cements. W. H. Broadhurst. Read before the Am. Soc. of Munic. Imp. Gives a detailed examination of the properties, and account of tests. 1500 w. Munic Engng—Nov., 1899. No. 30578 C.

Bricklaying.

See Architectural Engineering, Construction.

Brick Tests.

Strength of Brick Work. A summary of tests of brick piers. Ill. 900 w. Brick—Nov. 1, 1899. No. 30691.

Cement.

Cement Rock in Florida. From the report of Uriah Cummings concerning this remarkable deposit of natural hydraulic cement. 900 w. Brick—Nov. 1, 1899. No. 30690.

Economics of Cement Mortar. Ira O. Baker. Abstract. Presents methods of equating results, and discusses tests and related subjects. 1400 w. Pro of Ill Soc of Engs & Surv—1899. No. 30547 E.

Some Experiences with Portland Cement. W. K. Eldridge. Read before the Am. Soc. of Munic. Imp. An account of experiments and results. 3000 w. Munic Engng—Nov., 1899. No. 30579 C.

Concrete.

Tests of Cement and Concrete (Cement und Beton proben). Josef Schustler. A tabulated account of tests made during 1896-97 in the laboratory of Robert Wünsch at Budapest, with carefully arranged data concerning the various specimens tested. Two articles. 5000 w. Zeitschr d Osterr Ing u Arch Ver—Oct. 20, 27, 1899. No. 31019 each B.

Drying.

The Determination of Atmospheric Humidity in Drying Plants (Beitrage zur Bestimmung der Atmosphärischen Feuchtigkeit in Trockenanlagen). Paul Fuchs. A study of hygrometry from the technological standpoint, giving practical methods of determining the moisture in connection with drying apparatus. 3000 w. Gesundheits-Ingenieur—Oct. 31, 1899. No. 31041 B.

Fatigue.

Note Upon Actual and Computed Fatigue (Note sur les Fatigues Réelles et les Fatigues Calculées). M. Mesnager. An account of a series of tests made upon two girder bridges on the Orleans railway. The observed deformations agreed fairly with the computations. 8000 w. 3 plates. Ann des Ponts et Chaussées—2 Trimestre. 1899. No. 31083 E + F.

Stone.

See Architectural Engineering, Construction.

Structural Steel.

See Mining and Metallurgy, Iron and Steel.

MUNICIPAL.

Consolidation.

The Financial Effects of Consolidation. Bird S. Coler. A lecture at Cooper Union by the Comptroller of New York, on the results of the greater New York consolidation. 4000 w. Eng Rec—Nov. 25, 1899. No. 30955.

The Penalties of Bigness. An editorial review of certain troublesome problems which have resulted from the growth of London particularly; refers to water and sewerage projects. 1200 w. Eng Rec—Nov. 25, 1899. No. 30946.

Disinfecting.

The Disinfecting Station at Zurich. James H. Fuertes. Illustrated description of the municipal station and its fittings. 1000 w. Eng Rec—Nov. 11, 1899. No. 30713.

Drainage.

See Construction.

Municipal Works.

The Municipal Gas and Water Works at Halle on Saale (Die Stadtische Gas und Wasserwerke zu Halle a. S.). A full report of the construction and operation of the plant, with plan showing the arrangement of the gas works and of the sand filters. 3500 w. 1 plate. Gesundheits-Ingenieur—Oct. 31, 1899. No. 31042 B.

Pavements.

Brick Paving in Several Cities. L. M. Hastings. Read before the Am. Soc. of Munic. Imp. Information concerning the manufacture, wearing qualities, etc. 2300 w. Munic Engng—Nov., 1899. No. 30577 C.

The Life of Pavements. George W. Tillson. Read before the Am. Soc. of Munic. Imp. A study of the conditions affecting the life of city pavements. 5000 w. Munic Engng—Nov., 1899. No. 30576 C.

Paving.

A Portable Asphalt Paving Plant of Large Capacity. Illustrated description of a plant carried on two railway flat cars, containing all the machinery of an asphalt plant. 700 w. Eng News—Nov. 23, 1899. No. 30910.

San Francisco.

A Plan to Beautify Market Street. B. J. S. Cahill. An illustrated account of a plan to greatly beautify the city, with opinions of the scheme. 10300 w. Cal Arch—Oct., 1899. Serial. 1st part. No. 30792 D.

Sewage Disposal.

Sewage Disposal at Aldershot. A statement of the results obtained with the double bacteria-bed system. 1000 w. Eng Rec—Nov. 25, 1899. No. 30953.

Sewage Disposal Experiments at Leeds. A review of experiments with various bacterial processes, chemical treatment and land filtration. 1000 w. Eng Rec—Nov. 4, 1899. No. 30652.

The Moon Island Sewage Reservoir, Boston. Illustrated description of the new basins built to hold sewage until the tide was at the proper stage for its discharge into the sea. 1300 w. Eng Rec—Nov. 4, 1899. No. 30653.

The Provision for Storm Water in Sewage Purification Work. A. J. Martin. Condensed from a paper read before the Sanitary Inst., at Southampton. A discussion of the difficulties and statement of conclusions. 2800 w. Eng News—Nov. 16, 1899. No. 30803.

The Sewerage of Walsall, England. Illustrated description of works including some sewers running under a head, and a disposal system with chemical treatment supplemented by land filtration. The results of the treatment are stated, and an unusual dredge for cleaning sewers is illustrated. 2500 w. Eng Rec—Nov. 18, 1899. No. 30837.

The Use of Coke in the Treatment of Sewage. Review of the report of Frank Clowes on the bacterial treatment of sewage, givng an account of experiments carried out on the crude sewage of London in the coke-beds at Crossness. 5000 w. Jour Gas Lgt—Oct. 24, 1899. No. 30633 A.

Sidewalks.

Specifications for Concrete Sidewalks and Driveways. Specifications employed in laying walks around the grounds of the Univ. of Kansas. Abstract. 1000 w. Eng News—Nov. 9, 1899. No. 30700.

Street Traffic.

Address of Sir John Wolfe Barry. Discusses street improvements and their estimated cost, and the results attained. Maps. 6000 w. Jour Soc of Arts—Nov. 17, 1899. No. 30965 A.

London Street Traffic. Editorial discussion of paper by Sir John Wolfe Barry. 2000 w. Engng—Nov. 17, 1899. No. 30985 A.

Water Rates.

Water Rates in the Larger Cities of the United States. August Herrman. Read before the Am. Soc. of Munic. Imp. The report considers the rates of 31 cities. 3500 w. Munic Engng—Nov., 1899. No. 30574 C.

Water Works.

See Civil Engineering, Hydraulics.

MISCELLANY.

China.

Public Works at Talienwan. A clipping from the *North China News* in regard to the extensive public works undertaken at this new Russian port. 1000 w. U. S. Cons Repts, No. 584—Nov. 20, 1899. No. 30848 D.

France.

Recent French Engineering. W. H. Booth. Notes on things observed during a recent visit which show ability of French engineers. 1200 w. Am Mach—Nov. 23, 1899. No. 30925.

Military Engineering.

The Volunteer Engineers in the War with Spain. J. L. Van Ornum. A statement of the value, as shown by recent experience, of permanent volunteer engineering regiments in the State militia. 1300 w. Eng Rec—Nov. 25, 1899. No. 30952.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable.

The All-British Cable. Full text of the report by the Postmaster-General of South Australia. 4500 w. Elect'n, Lond—Oct. 20, 1899. No. 30528 A.

Galvanometer.

The Sullivan Signalling Galvanometer. Illustrates and describes the instrument and its working, which enables a commander in war time to establish communication through any submarine cable. 1400 w. Elec Rev, Lond—Nov. 3, 1899. No. 30774 A.

Marconi Patents.

Marconi Wireless Telegraph Patents. From the London *Electrician*. Gives the substance of the first three patents, with illustrations. 2200 w. Elec Wld & Engr—Nov. 11, 1899. No. 30727.

Repeater.

A Repeater for Use in Wireless Telegraphy. Illustrates and describes an instrument designed by Emile Guaricci-Foresio. 900 w. Elec Rev, Lond—Nov. 10, 1899. No. 30860 A.

Space Telegraphy.

Experiments in Wireless Telegraphy between Chamonix and the Summit of Mont Blanc (Expériences de Télégraphie sans Fil, Executées entre Chamonix et le Sommet du Mont Blanc). MM. J. and L. Lecarme. A communication to the French Academy, giving the details of these successful communications between stations of widely differing altitude. 1000 w. Comptes Rendus—Oct. 16, 1899. No. 31010 D.

Wireless Telegraphy. William Baxter, Jr. An explanation of the principles of the system used by Marconi in reporting the recent races for the America's cup. Ill. 2500 w. Mach, N. Y.—Nov., 1899 No. 30562.

Telegraph.

Abuse of the Telegraph. W. W. Ryder. Extracts from a paper read before the St. Louis Ry. Club. Calls attention to the overcrowding and unnecessary use of the telegraph. Also discussion. 3500 w. Ry & Engng Rev—Nov. 4, 1899. No. 30669.

DISTRIBUTION.

Alternating Currents.

The Drop in Alternating-Current Wires. Cecil P. Poole. Discussion of methods of computing. 800 w. Elec Wld & Engr—Nov. 18, 1899. No. 30811.

Conduits.

Underground Conduits for Electrical Conductors. C. H. Sewall. Gives briefly a review of the history of underground construction, and describes various types of conduit and the requirements of construction, with measures for meeting them. 2500 w. Elec Engng & Tel Mag—Nov., 1899. No. 30934.

Currents.

The Distribution of Currents in Alternating Circuits (Ueber Stromvertheilung in Wechselstromnetzen). C. P. Feldmann & Josef Herzog. Methods for various numbers of conductors are shown, and a variety of numerical examples given. 4500 w. Elektrotech Zeitschr—Nov. 9, 1899. No. 31073 B.

Electric Wire.

Electric Wire in Buildings. Alton D. Adams. A discussion of various systems and methods. 1600 w. Arch & Build—Nov., 1899. Serial. 1st part. No. 30607.

Protection.

The Protection of Secondary Circuits from Fire Risks. Cary T. Hutchinson. A statement of the dangers, and the means of protection that have been employed, recommending the grounding of secondaries. Also discussion. 9500 w. Trans Am Inst of Elec Engs—Aug.-Sept., 1899. No. 30541 D.

Transformer.

A New Type of Transformer (Ueber eine Neue Type von Transformatoren). C. P. Feldmann. An illustrated description of the new Helios transformer, in which the method of winding is simplified. 1500 w. Elektrotech Zeitschr—Nov. 2, 1899. No. 31072 B.

Wiring.

An Electric Wiring "Reverie." Fred. Bathurst. A discussion of systems in use. 2200 w. Elec, Lond—Oct. 27, 1899. No. 30629 A.

ELECTRO-CHEMISTRY.

Electro-Chemical Plants.

Prof. Lunge, of Zurich, on the Future of Water-Power and Electrolytic Alkali Processes. John B. C. Kershaw. A review of lecture delivered in Liverpool on the changes now being brought about by the utilization of water-power for industrial purposes, especially for chemical manufactures. 1600 w. Elec Rev, Lond—Oct. 20, 1899. No. 30533 A.

Electrolysis.

Electrolytic Processes in Industrial Operations. Dr. W. Borchers. An account of the wonderful progress of electrochemical manufacturing, with descriptions and diagrams of the more important forms of apparatus and tables of output, value, and power employed. Points out especially the way in which otherwise wasted water-power has been employed in this industry. 4000 w. Engineering Magazine—Dec., 1899. No. 31094 B.

Electrolytic Generator.

The Apparatus for the Commercial Generation of Oxygen and Hydrogen by the Electric Current. W. S. Franklin. An illustrated detailed description. 800 w. Am Elect'n—Nov., 1899. No. 30603.

Electro-Metallurgy.

The Electrolytic Treatment of Complex Sulphide Ores. Sherard Cowper-Coles. Briefly describes a number of electrolytic processes, confining the paper to wet extraction processes. 2500 w. Elect'n, Lond—Nov. 10, 1899. Serial. 1st part. No. 30861 A.

Explosion.

The Recent Explosion at St. Helens. Gives the gist of the report made by Colonel A. Ford on the circumstances attending the explosion which occurred on May 12, at the Kurtz Chemical Works. Map. 3000 w. Engr, Lond—Nov. 17, 1899. No. 31101 A.

Ozone.

Ozone and Its Technical Applications (Ozon und seine Technische Verwendung). A review of the discovery and history of ozone, and an account of its modern applications in bleaching, sterilisation, and other oxidising uses. Two articles, 4500 w. Die Elektrizität—Oct. 28, Nov. 11, 1899. No. 31085 each B.

The Ozonization of Water (L'Eau Ozonisée). E. Andréoli. A discussion of the oxidizing action of ozone upon organic matter contained in water, calling attention to the many extravagant claims which have been made for the process as distinguished from its real merits. 1200 w. L'Electricien—Nov. 4. 1899. No. 31088 B.

The Sterilization of Water by Ozone. Abstract translation of an article by Th. Weyl, in *Centralblatt für Bakteriologie,* with criticism by Robert Spurr Weston. 900 w. Eng News—Nov. 23, 1899. No. 30918.

ELECTRO-PHYSICS.

Alternating Currents.

The Determination of the Wave Form of Alternating Currents Without a Contact Maker. Harris J. Ryan. Illustrated description of a method which may be used when the special contact maker apparatus is not available. Discussion. 4000 w. Trans Am Inst of Elec Engs—Sept., 1899. No. 30539 D.

Alternators.

Comments Upon M. Blondel's Theory of Inductor Reaction (Observation sur une Note de M. Blondel Relative à la Réaction d'Induit des Alternateurs). A. Potier. A communication to the French Academy discussing mathematically the theory of M. Blondel. 1500 w. Comptes Rendus—Oct. 23, 1899. No. 31012 D.

Inductor Reactions of Alternators (Sur les Réactions d'Induit des Alternators). A. Blondel. A communication to the French Academy showing how the reaction may be referred to two or three coefficients of self-induction. 1500 w. Comptes Rendus—Oct. 16, 1899. No. 31009 D.

Hertz Waves.

The Transmission of Hertz Waves Through Liquids (Transmission des Ondes Hertziennes à Travers les Liquides). E. Branly. A communication to the French Academy showing the various absorbing powers of different liquids and describing the apparatus and method of investigation. 1500 w. Comptes Rendus—Oct. 30, 1899. No. 31014 D.

Impedance.

The Current Produced in an Inductive Coil by a Parabolic Wave of E. M. F. Alexander Russell. Mathematical solution. 800 w. Elec Rev, Lond—Nov. 10, 1899. No. 30858 A.

Inductance.

The Inductance of a Portion of an Electric Circuit. H. N. Allen. Shows some of the difficulties that may arise, and the means of avoiding them. 1700 w. Elect'n, Lond—Nov. 17, 1899. Serial. 1st part. No. 30977 A.

Induction.

The Influence of Self-Induction Upon the Rate of the Wehnelt Interrupter (Ueber den Einfluss der Selbstinduktion auf die Unterbrechungszahl beim Wehneltschen Unterbrecher). Ernst Ruhmer. A discussion of the theory of Dr. Simon, and a comparison of the computed results with the writer's experiments. 2000 w. Elektrotech Zeitschr—Nov. 9, 1899. No. 31075 B.

Interrupter.

A New Universal Mercurial Jet Interrupter (Ein Neuer Universal Quecksilberstrahlunterbrecher). Dr. Max Levy. A toothed crown wheel is rapidly rotated by an electric motor, and a jet of mercury forced against the teeth. 2000 w. Elektrotech Zeitschr—Oct. 12, 1899. No. 31063 B.

The Mechanism of the Wehnelt Interrupter. On the investigations by Voller and Walter explaining the various processes to which the action is due. 2400 w. Elec Rev, Lond—Oct. 20, 1899. No. 30532 A.

The Wehnelt Electrolytic Interrupter (Sur l'Interrupteur Electrolytique de Wehnelt). E. Rothé. A communication to the French Academy describing the behavior of the interrupter when, for a constant electromotive force, the external resistance is varied. 1200 w. Comptes Rendus—Oct. 30, 1899. No. 31015 D.

Laboratory.

The High-Pressure Plant in the Electrochemical Laboratory of the Zürich Polytechnic (Die Starkstromanlage In Elektrochemischen Laboratorium des Eidg. Polytechnikums in Zurich). F. Largiader. With plan and photographs of the building showing arrangement of the switches, converter, instruments, etc. 1800 w. Schweizerische Bauzeitung—Nov. 11, 1899. No. 31048 B.

Lines of Force.

The Distribution of Lines of Force in Grooved Armatures (Ueber die Kraftlinienvertheilung in Nuthenankern). Dr. F. Niethammer. An elaborate mathematical treatment, with diagrams, to assist in the determination of the ampere windings. 6000 w. Elektrotech Zeitschr—Nov. 2, 1899. No. 31071 B.

Magnetic Flux.

Air-Gap and Core Distribution. W. Elwell Goldsborough. This second article treats of the magnetic flux and its effect upon the regulation and efficiency of dymano-electric machinery. Also discussion. 5500 w. Trans Am Inst of Elec Engs—Oct., 1899. No. 30932 D.

Magnetism.

The Relation of Magnetism to Electricity. Charles R. Gibson. A review of investigations, describing experiments. Ill. 3500 w. Elec, Lond—Oct. 27, 1899. No. 30628 A.

Magneto-Optics.

Magneto-Optic Rotation and Its Explanation by a Gyrostatic System. A discourse delivered at the Royal Inst. by Andrew Gray. Illustrates and describes investigations. 2800 w. Sci Am Sup—Dec. 2, 1899. Serial. 1st part. No. 31116.

Ohm's Law.

Ohm's Law According to the Vibration Theory (Das Ohm'sche Gesetz nach der Vibrations Theorie). Rudolf Mewes. A mathematical examination of the vibration theory of resistance as compared with the observed facts, showing that Ohm's is in accordance with the equations for mechanical work. 1500 w. Elektrochemische Zeitschr—Nov., 1899. No. 31076 G.

Phase-Difference.

Means for Producing Large Differences in Phase (Ueber Mittel zur Erreichung Crosser Phasenverschiebung). J. Görner. A mathematical discussion, with diagrams showing several methods applicable in practice. The applications of the methods are shown in the Hartmann & Braun meter. 2500 w. Elektrotech Zeitschr—Oct. 26, 1899. No. 31069 B.

Radiography.

A Simple Form of Influence Machine for X-Ray Work. William Cotton. Abstract from the *Bristol Medico-Chirurgical Journal.* Describes a sectorless Wimshurst machine and gives the results obtained. 4000 w. Elect'n, Lond—Oct. 27, 1899. No. 30632 A.

Radiograph Tube with Cool Anti-Cathode (Ampoule Radiographique à Anticathode Froide). MM. Buguet and Chabaud. A communication to the French Academy describing a method of cooling the terminal in a Crookes tube by means of a circulation of water or mercury. 1000 w. Comptes Rendus—Oct. 16, 1899. No. 31011 D.

The Pidgeon Influence Machine. Illustrates and describes a machine adapted for X-ray purposes. 2000 w. Elec Rev, Lond—Nov. 10, 1899. No. 30859 A.

Sparking.

A Discussion of Sparking in the Continuous-Current Dynamo (Beurtheilung der Gleichstrommaschinen in Bezug auf die Funkenbildung). Heinrich Isler. A mathematical treatment reviewing especially the recent theories of Dr. Fischer-Hinnen. Two articles. 6000 w. Elektrotech Zeitschr—Oct. 12, 19, 1899. No. 31062 each B.

An Analysis of Spark Discharges (Analyse von Funkenentladungen). Jul. H. West. Illustrated with many illustrations made in the mutoscope by continuous photography, showing the action of successive sparks. The Wehnelt interrupter was used. 3000 w. Elektrotech Zeitschr—Oct. 26, 1899. No. 31068 B.

GENERATING STATIONS.

Accumulators.

Computations for Equalizing Accumulators (Beitrag zur Berechnung von Buffer batterien). G. Brandt. A discussion of the method of computing the size of storage battery for equalizing the load in a traction power house, based upon the experiments of Siemens & Halske. 3000 w. Elektrotech Zeitschr—Oct. 19, 1899. No. 31066 B.

Measurement of the Internal Resistance of Accumulators. E. C. Remington. Explains method used by the writer, suggesting modifications that would probably work as well. 1500 w. Elec Rev, Lond—Oct. 20, 1899. No. 30531 A.

The Majert-Accumulator (Der Majert-Akkumulator). A. Wilke. With many illustrations showing the details of manufacture of the lead plates, including the special machinery for forming the cellular surface. Tables of data of capacity and endurance are given. 3500 w. Elektrotech Zeitschr—Nov. 9, 1899. No. 31-074 B.

Brooklyn, N. Y.

Brooklyn's Modern Electric Light Station. Illustrates and describes the generating plant of the Kings County Electric Light and Power Company. 3400 w. Elec Rev, N. Y.—Nov. 22, 1899. No. 30920.

The New Station of the Kings County Electric Light and Power Co. George T. Hanchett. Illustrated detailed description. 1700 w. Elec Wld & Engr—Nov. 25, 1899. No. 30961.

Brushes.

Brush Rocker Details and Bearings. E. K. Scott. Illustrated description of various arrangements. 1200 w. Elec Rev, Lond—Oct. 27, 1899. No. 30630 A.

Cost.

Cost of Central Station Plant. Gives a table indicating what the writer considers should be sizes of the plant for towns of various populations, and the cost. 900 w. Elec Rev, Lond—Nov. 17, 1899. Serial. 1st part. No. 30973 A.

The Cost of Electric Energy in 1898. A. P. Haslam. An analysis of results in England. 2500 w. Elec, Lond—Oct. 20, 1899. Serial. 1st part. No. 30627 A.

Direct Current.

Capacity Limits in Direct-Current Machines. Alton D. Adams. A discussion of the maximum possible rate of work in electrical machinery. 1200 w. Eng News—Nov. 23, 1899. No. 30916.

Dynamos.

Low-Voltage Dynamos. E. Kilburn Scott. Illustrated discussion of a few designs. 800 w. Elect'n, Lond—Oct. 20, 1899. No. 30526 A.

Dynamo Testing.

Methods of Dynamo Testing. Considers the indicator, the calibrated motor, and the stray-power methods. 1700 w. Engr, U. S. A.—Nov. 1, 1899. No. 30595.

Generators.

Double Voltage and Current Generators. Alton D. Adams. States the advantages of generators that are able to deliver their output as either direct or alternating current, or a part in each. 1200 w. Elec Wld & Engr—Nov. 11, 1899. No. 30728.

Switchboard Connections and Synchronizing Arrangements for Polyphase

Generators. Illustrates and describes several arrangements used by the Westinghouse Elec. & Mfr. Co. 2500 w. Am Elect'n—Nov., 1899. No. 30601.

Leicester, Eng.

The Leicester Electricity Works. Illustrated detailed description of the first works in England equipped entirely with the inductor type of alternator. 2400 w. Elec Eng, Lond—Oct. 20, 1899. No. 30-534 A.

Lighting Plant.

South Shields Corporation Electricity Works. Illustrated description of the installation for electric lighting. 2200 w. Elec Rev, Lond—Nov. 3, 1899. No. 30-776 A.

Motive Power.

The Generation and Electrical Distribution of Motive Power. John S. Raworth. Read before the Manchester Assn. of Engs. An explanation of the extent to which electric power may be economically applied to the driving of machines, and how the various problems may be solved. 3800 w. Engng—Nov. 3, 1899. No. 30753 A.

Parallel Driving.

The Parallel Connection of Alternators Driven by Gas Engines (Das Parallelschalten von Wechselstrommaschinen, die durch Gasmaschinen Betrieben Werden). G. Dettmar. Showing how the alternators may be synchronized by the use of a magnetic brake acting on the fly wheel of the gas engine. 2500 w. Elektrotech Zeitschr—Oct. 19, 1899. No. 31065 B.

Penig, Saxony.

The Municipal Electrical Works at Penig (Das Städtische Elektrizitätswerk in Penig). Dr. R. Rühlmann. A general description of the plant by which the power of the river Mulde is utilized for light and power-supply of the city of Penig. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 28, 1899. No. 31032 D.

Poland.

Warsaw, Poland, Central Station Plant. Reviews the report of W. H. Lindley, who was employed to investigate every detail, giving extracts. Part first discusses the advantages and disadvantages of direct and alternating currents. 3300 w. Elec Wld & Engr—Nov. 4, 1899. Serial. 1st part. No. 30586.

Powder Works.

The Light and Power Plant of the California Powder Works. Wyatt H. Allen. Illustrated description. 2400 w. Elec Wld & Engr—Nov. 11, 1899. No. 30726.

Power Station.

A New Electric Power Station. Woburn, Mass. L. R. Wallis. Illustrated description of a station containing novel features, which serves current for public and private lighting, street-railways and manufacturing purposes, to a territory of 30,000 population and 100 miles of streets. 2500 w. Eng Rec—Nov. 4, 1899. No. 30649.

Rheinfelden.

The Hydro-Electric Plant at Rheinfelden. Detailed description. 3400 w. Engng—Nov. 10, 1899. No. 30872 A.

Steam Dynamo.

See Mechanical Engineering, Steam Engineering.

Test.

Test of a 300-Kilowatt Direct-Connected Railway Unit at Different Loads. Edward J. Willis. A test of the steam, water, and coal consumption and electrical output. 1000 w. Trans Am Inst of Elec Engs—Oct., 1899. No. 30933 D.

HEATING AND WELDING.

Welding.

Electric Welding and Metal Working (Elektrische Schweissung und Metallbearbeitung). Hermann Lemp. Mainly devoted to a description of the apparatus and methods of Prof. Elihu Thomson. 3500 w. Elektrochemische Zeitschr—Nov., 1899. No. 31077 G.

LIGHTING.

Arc Lamps.

Enclosed Arc Lamp Statistics. L. B. Marks. Records of thirty-six central stations. 600 w. Elec Wld & Engr—Nov. 4, 1899. No. 30587.

Transformers for Series Arc Light Circuits. A statement of the present state of the art of operating alternating-current arc lamps in series, as given in patent specification granted to Waldo A. Layman and Ferdinand Schwedtmann. 2000 w. W Elect'n—Nov. 18, 1899. No. 30905.

Candle-Power.

Mean Spherical Candle-Power. Wilbur M. Stine. An examination of the theory of mean spherical and mean hemispherical candle-power, and the methods of calculating those qualities. 2000 w. Elec Wld & Engr—Nov. 18, 1899. No. 30810.

Capitol.

Electric Lighting in the Albany Capitol. Illustrates and describes the work. 2000 w. Arch Rec—Oct.-Dec., 1899. No. 30-733 C.

Incandescent Lamps.

The Advantages of Long Filaments in Incandescent Lamps. An explanation of the effect on high resistances, and discussion of the material used. 1800 w. Am Elect'n—Nov., 1899. No. 30600.

The High Voltage Lamp. A review of the present types now on the market. Ill. 600 w. Elect'n, Lond—Nov. 17, 1899. Serial. 1st part. No. 30978 A.

The Photometry of Incandescent Lamps. Arthur J. Rowland. Describes a special plan for readily procuring results, and the apparatus necessary for the purpose. Ill. 2200 w. Jour Fr Inst —Nov., 1899. No. 30605 D.

Light Company.

Allegheny County Light Company. An account of the works supplying the cities of Pittsburg and Allegheny with electric light. Ill. 2200 w. Engng—Nov. 10, 1899. No. 30873 A.

Lighting Plant.

See Generating Stations.

Standards.

Plea for a Working Standard of Light. S. Everett Doane. Note and discussion. 4200 w. Trans Am Inst of Elec Engs—Aug. and Sept., 1899. No. 30542 D.

Systems.

Public Lighting Systems. Editorial review of various arc-lighting systems. 2300 w. Elect'n, Lond—Oct. 20, 1899. No. 30527 A.

MEASUREMENT.

Meter.

Slippage Meter (Ueber Schlüpfungszähler). R. Seeman. Describing the Siemens & Halske device, consisting of separate counters on generator and motor. with attachment for simultaneous starting and stopping. 3000 w. Elektrotech Zeitschr—Nov. 2, 1899. No. 31070 B.

Resistance.

The Nalder Portable Apparatus for Measuring Feeble Resistances (Appareil Portatif Nalder pour la Mesure des Faibles Résistances). M. Aliamet. Describing an improvement over the Wheatstone bridge, which avoids the errors due to the resistances of contact. 1000 w. L'Electricien—Oct. 28, 1899. No. 31086 B.

POWER APPLICATIONS.

Cranes.

Electric Cranes. Illustrates both movable and stationary cranes to which electric power has been applied. 1600 w. Elec Rev, Lond—Nov. 17, 1899. Serial. 1st part. No. 30974 A.

Electric Traveling Crane of 35 tons Capacity (Pont Roulant Electrique de 35 Tonnes). A powerful 3-motor crane of 16 metres span, the details of which are fully shown in the illustrations. 1000 w. 1 plate. Génie Civil—Oct. 21, 1899. No. 31002 D.

Electrical Equipment.

See Marine Engineering.

Electric Driving.

Boring and Milling Machine, Electrically Driven (Bohr und Fräsmaschine mit Elektrischem Antriebe). Giving plan and elevation of a large and conveniently arranged tool, showing the adaptability of the electric motor to machine tool driving. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1899. No. 31025 D.

Electric Power.

See Mining & Metallurgy, Mining.

The Direct Driving of Machine Tools by Means of Polyphase or Multiphase Currents. Extracts from paper by O. Lasche, presented to the Berlin Soc. of Civ. Engs. Part first gives an illustrated description of the motor. 2500 w. Prac Engr—Nov. 10, 1899. Serial. 1st part. No. 30868 A.

Factory Transmission.

Transmission of Power in Factories. Discusses points relating to the application of motors for machine driving. 2400 w. Elec Rev, Lond—Nov. 3, 1899. No. 30775 A.

Power Plant.

See Generating Stations.

Speed Regulation.

Elements of Design Favorable to Speed Regulation in Plants Driven by Water Power. Allan V. Garratt. Describes those peculiarities of design which have a special bearing on speed regulation. Also discussion. 16700 w. Trans Am Inst of Elec Engs—Aug. and Sept., 1899. No. 30540 D.

Motor Speed Regulation. Alton D. Adams. Calling attention to the need of efficient means of regulation in variable speed motors. Discussion. 1400 w. Trans Am Inst of Elec Engs—Aug and Sept., 1899. No. 30543 D.

TRANSMISSION.

Conductors.

The Computation of Partially Fed Electric Conductors (Berechnung Einseitig Gespeister Elektrischer Leitungen). A. Hecker. A development of formulas intended to enable the computation of the most economical cross section. Two articles, 4500 w. Deutsche Zeitschr f Elektrotechnik—Oct. 15, Nov. 1, 1899. No. 31078 each G.

Discussion.

Some Notes on Electric Power Transmission. A report of statements at the Institution of Civil Engineers, by W. B. Esson, W. E. Ayrton, G. Forbes, Alexander Siemens, and others. 1200 w. Eng Rec—Nov. 18, 1899. No. 30843.

Polyphase.

The Line Losses of Polyphase Transmission. George T. Hanchett. An attempt to reconcile the varying results advanced by conceded authorities and to show how each is obtained. 1800 w. Am. Elect'n—Nov., 1899. No. 30602.

MISCELLANY.

Accidents.

First Help to the Injured in Electrical Accidents (Anleitung zur Ersten Hülfeleistung bei Unfällen in Elektrischen Betrieben). The rules issued by the German Elektrotechnical Society, with illustrations of the method of inducing artificial respiration. 1000 w. Elektrotech Zeitschr—Oct. 19, 1899. No. 31064 B.

Anniversary.

The Seventy-fifth Anniversary of the Franklin Institute from an Electrical Standpoint. Edwin J. Houston. Reviews the progress and the part played by the Institute. 8000 w. Jour Fr Inst—Nov., 1899. No. 30604 D.

Congress.

The Electrical Congress at Como (Der Elektriker-Kongress in Como). A general report of the Congress with abstracts of the papers presented. 5000 w. Elektrotech Zeitschr—Oct. 12, 1899. No. 31061 B.

Physiological Effect.

Death by Electric Discharges (La Mort par les Décharges Electriques). MM. Prevost and Battelli. A report upon experiments made upon dogs, rabbits and guinea pigs, at the University of Geneva, with details of the effects of currents. of various kinds. Oct. 23, 1899. No. 31013 D.

Switzerland.

Electrical Engineering in Switzerland. General consideration of the development of electrical enterprise. 3000 w. Engr, Lond—Oct. 27, 1899. No. 30620 A.

Volta.

Volta and the Voltaic Cell. Extracts from a lecture delivered in Como, by Prof. Augusto Righi. 4500 w. Elec Rev, Lond—Oct. 27, 1899. No. 30631 A.

GAS ENGINEERING

Acetylene.

The Action of Acetylene on the Oxides of Copper. F. A. Gooch and De Forest Baldwin. A report of investigations. 1800 w. Am Jour of Sci—Nov., 1899. No. 30553 D.

The 1899 Acetylene Congress at Nurnberg. Brief account of this meeting with abstracts of papers presented. 2500 w. Engr, Lond—Nov. 17, 1899. No. 30994 A.

The Explosive Side of Acetylene. Frederick H. McGahie. On the explosive limits and the conditions under which acetylene can be used with safety. 2800 w. Sci Am Sup—Dec. 2, 1899. No. 31119.

The Purification of Acetylene by Means of Chloride of Lime. Discusses the necessity of purification, the methods, and results. 2500 w. Engr, Lond—Nov. 3, 1899. No. 30756 A.

Address.

Presidential Address of Mr. A. C. Humphreys at the Annual Meeting of the American Gas Light Association. Discusses important subjects in connection with the gas industry. 5400 w. Jour Gas Lgt—Oct. 31, 1899. No. 30693 A.

Benzol.

Estimation of Benzol in Illuminating Gas. Otto Pfeiffer. Summary from the *Journal für Gasbeleuchtung*. Describes old methods of estimating and also the author's method. 2800 w. Gas Wld—Nov. 4, 1899. No. 30772 A.

Explosion.

Explosion at Manchester Corporation Gas Works. An illustrated account of an explosion, resulting in the death of the manager, Mr. G. E. Stevenson, and the injury of others. Also a sketch of Mr. Stevenson's life. 4500 w. Gas Wld—Nov. 4, 1899. No. 30773 A.

Gas Firing.

See Mechanical Engineering, Steam Engineering.

Gas Works.

The Gas Works at Ponce, Puerto Rico. D. L. Hough. Brief historical account of the gas business in Puerto Rico. 4500 w. Am Gas Lgt Jour—Nov. 13, 1899. No. 30744.

Governors.

Notes on the Working of a Self-Loading Governor. W. Whatmough. Read before the Manchester Dist. Inst. of Gas Engs. Gives results of the working at the Heywood Gas Works. 2400 w. Gas Eng's Mag—Nov. 10, 1899. No. 30967 A.

Liquefaction.

Compression and Liquefaction of Gases. Arthur L. Rice. Historical and scientific review. 4500 w. Trans Am Soc of Mech Engs, No. 829—Dec., 1899. No. 30885 C.

Meters.

Gas Supply by Automatic Meter. H. O. Eldridge. Read at meeting of So. Dist. Assn. of Gas Engs. and Mgrs., England. Also discussion. Outlines the conditions and success attained at Tottenham. 5500 w. Gas Wld—Nov. 11, 1899. No. 30856 A.

The Prepayment Meter System. Part first deals with its history and development. 1800 w. Gas Eng's Mag—Nov. 10, 1899. Serial. 1st part. No. 30966 A.

Municipal Works.

See Civil Engineering, Municipal.

Office.

The Manager's Town Office. N. H. Humphreys. Read before the So. Dist. Assn. of Gas Engs. and Mgrs., England. Recommendations helpful in advancing the business of the gas industry. 4800 w. Gas Wld—Nov. 11, 1899. No. 30855 A.

Photometry.

Some Experiments with the Edgerton Standard. Rollin Norris. Read before the Am. Gas Lgt. Assn. Detailed account of experiments made to find out how reliable is this standard. 4800 w. Am Gas Lgt Jour—Nov. 6, 1899. No. 30666.

Retorts.

Inclined Retorts. B. W. Smith. Read before the Midland Assn. of Gas Mgrs. Describes the operation of the inclined retorts at the Smethwick gas works. 3000 w. Gas Wld—Oct. 28, 1899. No. 30615 A.

Notes on the Heating of Gas Retorts. George Helps. Read before the Midland Assn. of Gas Mgrs. Discusses systems of firing, recuperators, waste gases, etc. 4000 w. Gas Wld—Oct. 28, 1899. No. 30614 A.

Retort Heating. G. P. Lewis. Observations on some points brought out in a recent paper by G. Helps. 1700 w. Gas Wld—Nov. 18, 1899. No. 30975 A.

Water Gas.

An Outline Description of Carburetted Water-Gas Manufacture. John M. Rusby. Ill. 3000 w. Stevens Ind—Oct., 1899. No. 30555 D.

Carburetted Water Gas as a Coal Gas Auxiliary. A. G. Glasgow. Read before the Am. Gas Lgt. Assn. Considers works of sufficient size for the dual system of production, and suggests how the ultimate result of joint production may be anticipated for comparison with either system singly. 2500 w. Am Gas Lgt Jour—Nov. 13, 1899. No. 30743.

Water Gas (Wassergas). Dr. Gerdes. A general discussion of the composition and properties of water gas, with a description of a complete plant as constructed by Julius Pintsch, of Berlin. 4500 w. Zeitschr d Ver Deutscher Ing —Nov. 11, 1899. No. 31037 D.

Wolverhampton.

An Example of Gas Engineering Work from Wolverhampton. Describes an interesting example of modern gas engineering. 2700 w. Jour Gas Lgt—Oct. 31, 1899. No. 30692 A.

Zürich.

The New Gas Works of the City of Zürich at Schlieren (Das Neue Gaswerk der Stadt Zürich in Schlieren). A. Weiss. A complete account of the new gas works constructed in an outlying suburb, since the consolidation of the old city of Zürich with the surrounding districts. Serial. Part I. 2000 w. 1 plate. Schweizerische Bauzeitung—Oct. 28, 1899. No. 31046 B.

MARINE AND NAVAL ENGINEERING

Armor-Clad.

The Modern Armor-Clad. Translated from *Le Monde Moderne*. Reviews the history of the armor-clad ship-of-war, and the progress in the manufacture of armor plates and projectiles. Ill. 3500 w. Sci Am Sup—Dec. 2, 1899. Serial. 1st part. No. 31115.

Armor Plates.

American Armor Plate for a Russian Battleship. Illustrates recently tested armor plates manufactured by the Carnegie Co., giving an account of results. 900 w. Sci Am—Nov. 25, 1899. No. 30930.

Krupp Armor-Plate Tests. Illustrated description of recent tests. 600 w. Sci Am Sup—Dec. 2, 1899. No. 31118.

Automatic Sight.

An Automatic Sight with a Maximum and Minimum Height Cam. H. C. Dunlop. Gives directions for cutting a cam that shall give the proper angles of elevation to the gun at all heights of tide. Ill. 1000 w. Jour U. S. Art—July-Aug., 1899. No. 30660 D.

Ballistic Table.

New Ballistic Table for Direct Fire. James M. Ingalls. Gives ballistic tables for direct fire, based on the quadratic law of resistance. 1800 w. Jour U. S. Art—July-Aug., 1899. No. 30659 D.

British Shipping.

British Merchant Shipping. Editorial on the effect of the withdrawal of the fleet for army service, which aggregated nearly 630,000 tons. 1700 w. Engng—Oct. 27, 1899. No. 30618 A.

Bulkheads.

Beam Formulæ Applied to a Vertically

Stiffened Bulkhead, with Some Results. No. 6. H. F. Norton. A mathematical analysis. Plate. 3500 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30825 E.

Cable Ship.

The New Cable-Ship "von Podbielski." Describes a ship owned by Germany, recently launched at Port Glasgow. 2000 w. Elect'n, Lond—Nov. 17, 1899. No. 30976 A.

Coaling.

Coaling Vessels at Sea. No. 1. Spencer Miller. Reviews various plans that have been suggested and describes the author's experiments with the Miller conveyor on the U. S. S. Marcellus. Ill. 8000 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30820 E.

Cruisers.

Designs for the Denver Class, Sheathed Protected Cruiser. No. 10. Philip Hichborn. A description of the sheathed protected cruisers provided for in the last appropriations for increase of the U. S. Navy. 9 plates. 2500 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30829 F.

The Dutch Cruiser Noord Brabant. Illustrates this vessel and its engines, giving a brief description. 400 w. Engr, Lond—Nov. 10, 1899. No. 30866 A.

Electric Equipment.

Application of Three-Wire System to Marine Electric Plants. Cecil P. Poole. Discusses several plans, describing the arrangements. Ill. 1600 w. Marine Engng—Nov., 1899. No. 30612 C.

The Electrical Equipment of the Largest Ship Afloat. An illustrated description of the electric lighting, electric motor and telephone systems on the steamship "Oceanic." 2000 w. Am Elect'n—Nov., 1899. No. 30598.

The Electric Plants of the Battleships Kearsarge and Kentucky. No. 4. J. J. Woodward. Description of the plants with a statement of the duties performed. 20 plates. 22000 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30823 F.

Engines.

The S. S. America Maru. Illustrated description of the triple-expansion engines. 1000 w. Engr, Lond—Oct. 27, 1899. No. 30623 A.

Gun Carriages.

The 15 Cm. Marine Carriage and the Krupp Tilting Carriage (Die 15 Cm. Schiffslaffeten und die Kruppsche Wiegenlaffete). J. Castner. Illustrated description of recent German gun-carriages, with especial reference to wide range of movement, and recoil bearings for rapid-fire. 3000 w. Stahl and Eisen—Nov. 1, 1899. No. 31054 D.

Lighthouses.

A Circular Steel Light-Tower at Sturgeon Bay Canal, Wisconsin. Illustrated description of a new type of light-house, favored because of its simplicity, small cost and lasting qualities. 700 w. Eng News—Nov. 9, 1899. No. 30697.

Methods of Revolving the Optical Apparatus for Lighthouses. D. P. Heap. Illustrated description. 2200 w. Sci Am —Nov. 25, 1899. No. 30929.

Merchant Marine.

Our Merchant Marine upon the Oceans. George F. Edmunds. Discusses ways of increasing foreign trade and of putting the carrying trade in the hands of the United States as far as its own products are concerned. 2500 w. Marine Rev—Nov. 2, 1899. No. 30664.

Power Formulae.

The Admiralty Co-efficient with Facts Gleaned from Torpedo Boat Steam Trials. William A. Fairburn. Shows that as the speed of vessels increases, the flaws in all power formulæ become more pronounced, and discusses their value. 4000 w. Marine Rev—Nov. 9, 1899. No. 30742.

Rudders.

On the Action of the Rudder, with Special Reference to the Motion of the Ship While the Helm Is Being Put Over. No. 14. William F. Durand. Collection of data and account of experimental investigations. Mathematical. 12 plates. 4200 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30833 E.

Sheathing.

Notes on Sheathing the U. S. S. Chesapeake. No. 7. Lloyd Bankson. Describes the process of sheathing this steel vessel with wood. 3 plates. 1200 w. Soc. of Nav. Archts & Marine Engs—Nov., 1899. No. 30826 E.

Shipbuilding.

A New England Ship Building Industry. Illustrates and describes the plant of the Fore River Engine Co., at Weymouth, Mass. 2000 w. Marine Rev—Nov. 2, 1899. No. 30663.

Ship Fittings.

Novelties in Ship Fittings. No. 11. R. M. Watt. Illustrates and describes a safety electric water-tight door, asbestos sheathing, metal folding berth, and metal skylight. 5000 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30830 E.

Ships' Boats.

Suggestions as to Improved Appliances for Launching Ships' Boats. No. 3. John Hyslop. Discusses davits and the means of operating them, also other appliances, and the need of improvement. Ill. 4200 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30822 E.

Shipyards.

Overhead Cranes, Staging, and Riveter-Carrying Appliances in the Shipyard. No. 9. James Dickie. Detailed description of these appliances. 6 plates. 1600 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30828 E.

System of Work in a Great Lake Shipyard. No. 8. W. I. Babcock. Describes the practice of the Chicago Ship-Building Company as applied to the ordinary lake bulk freight vessel of large size. 20 plates. 4700 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30827 E.

Speed Trials.

Progressive Speed Trials of the U. S. S. Manning. No. 12. Cecil H. Peabody. Observations taken during the tests and analysis of progressive speed trials. Plates. 2200 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30831 E.

Steamships.

Steamship Ponce for Regular Service between New York and Porto Rico. Illustrates and describes this large new freight and passenger steamer, of the spar deck type. 500 w. Marine Engng—Nov, 1899. No. 30611 C.

Steel Steamer.

A Modern Lake Lumber Carrier. An Illustrated description of the steel steamer Jessie Spalding, recently built at West Bay City, Mich. 2000 w. Marine Rev —Nov. 2, 1899. No. 30665.

Steering.

On the Steering of Ships and the So-Called "Patent Ship Steering Gear." C. W. Suppan. Reprint from *Zeitschrift des Oesterr Ingenieur und Architekter-Vereins.* Treats of the rudder and steering gear, giving illustrated description of the mechanical apparatus named. 3000 w. Ir & St Trds Jour—Nov. 11. 1899. No. 30919 A.

Submarine Boat.

Tests of the Holland Submarine Boat. Brief notice of recent tests, with description of the electrical equipment. Ill. 800 w. Elec Wld & Engr—Nov. 4, 1899. No. 30588.

Topography.

Coastal Topography of the United States. Oscar C. S. Carter. An interesting and general description, with illustrations of special portions. 7000 w. Pro of Engs' Club of Phila—Oct., 1899. No. 30881 D.

Torpedo Boats.

Tactical Considerations Involved in Torpedo Boat Design. No. 13. A. P. Niblack. Discusses the characteristics of these boats, considered especially in relation to their operation. 4500 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30832 E.

Transports.

The Transport of Troops. Illustrates the Castle Liner "Kildonan Castle" as a troop-ship, considering its fittings as ideal for this purpose. 1000 w. Engng—Nov. 17, 1899. No. 30983 A.

Turrets.

A Discussion of the Superimposed Turret for Warships. Presents the arguments in favor and against the system. 1400 w. Sci Am—Nov. 25, 1899. No. 30928.

Schneider-Canet Naval Turrets. Illustrated detailed descriptions of these turrets and their operation. 2500 w. Sci Am Sup—Nov. 18, 1899. No. 30788.

U. S. Navy.

Comprehensive Scheme of Naval Increase. A. M. Bailey. From the *N. Y. Sun.* Discussing the vessels needed to complete the present equipment and furnish the country the protection required. 5800 w. Marine Rev—Nov. 16, 1899. No. 30844.

Warships.

The Increasing Complications in Warships, and How Simple Arrangements Might be Adopted. No. 5. George W. Dickie. Calls attention to points where improvement in effectiveness and simplicity can be effected as compared with present practice. 5 plates. 7000 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30824 E.

Water-Tubes.

Causes for the Adoption of Water-Tube Boilers in the U. S. Navy. No. 2. George W. Melville. Considers the decision of the United States Government to use nothing but water-tube boilers a step in advance, giving reasons for opinions. 4500 w. Soc of Nav Archts & Marine Engs—Nov., 1899. No. 30821 E.

Water-Tube Boilers in Marine Service. I. W. Chubb. Brief discussion of the advantages and disadvantages of water-tube boilers. 1800 w. Prac Engr—Oct. 20, 1899. No. 30530 A.

Yachting.

Yachting on the Great Lakes. Waldon Fawcett. Illustrated description of the boats used in contests between the United States and Canada. 2000 w. Sci Am—Nov. 4, 1899. No. 30583.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Acetylene Motor.

Actylene Motor Wagons and Carriages. Illustrates a victoria and the running gear of a standard truck for delivery wagons, operated by acetylene gas. 800 w. Sci Am—Nov. 11. 1899. No. 30678.

Auto Race.

An American Auto Race. Brief report of the race at Galesburg, Ill. Ill. 800 w. Auto Mag—Nov., 1899. No. 30549 C.

Bearings.

Axle Bearings. Myron and Frederick B. Hill. A study of the advantages and disadvantages of various bearings. Ill. 3000 w. Auto Mag—Nov., 1899. No. 30551 C.

Electric Vehicle.

The Electric Automobile. Félicien Michotte. Part first discusses the motors and accumulators. Ill. 2500 w. Auto Mag—Nov., 1899. Serial. 1st part. No. 30552 C.

Gurney Coach.

The First Motor Ride. John Grand Carteret. An account of a ride in a motor carriage in 1829. Ill. 1500 w. Auto Mag—Nov., 1899. No. 30550 C.

Italy.

Automobiles and their Future in Italy (Gli Automobili ed il loro Avvenire in Italia). Guiseppe Spera. A report to the Commissioner of Public Works, discussing the relation of the automobile to the improvement of highways and the possible competition of automobile traction with railways. 2000 w. Rivista Gen dell Ferrovie—Oct. 29, 1899. No. 31089 B.

Kerosene Motor.

The Secor Oil Motor. Hugh Dolnar. Reply to the criticisms of Mr. J. D. Lyon. 700 w. Am Mfr & Ir Wld—Nov. 9. 1899. No. 30721.

Motor Vehicles.

Motor Vehicles in the Stock Market. Editorial discussion and warning, considering the four kinds of motive power used, and reviewing the standing of the industry. 2000 w. Eng News—Nov. 2, 1899. No. 30687.

Two Novel Automobiles. Frank H. Mason. Describes two vehicles exhibited recently in Berlin, the Pieper double-motor carriage and the "Electra." 1200 w. Am Mfr & Ir Wld—Nov. 2, 1899. No. 30662.

Renault Car.

The Renault Motor-Voiturette. An illustrated description of an application of the De Dion motor to light motor-vehicles. 500 w. Ind & Ir—Nov. 3, 1899. No. 30755 A.

Steam Wagons.

A Short Account of Some Modern Steam Wagons. George A. Burls. Excerpt of paper read before the Civil and Mech. Engs. Soc. A general discussion of the efficiency, durability, power, speed, etc., of these vehicles, with table of data, and short discussion. 5000 w. Automotor Jour—Nov., 1899. No. 30968 A.

Steering Gears.

A Study of Steering Gears With Two Pivots. Mostly taken from some recent contributions to *La Génie Civil* and *Engineering*. Ill. 2000 w. Automotor Jour—Nov., 1899. No. 30969 A.

Warfare.

The Automobile in War. Edwin Emerson, Jr. Illustrates and describes the various automotor guns and gun-carriages, discussing their efficiency and utility. 3800 w. Auto Mag—Nov., 1899. No. 30548 C.

HYDRAULICS.

Brake.

The Design of Hydraulic Brakes (Sur le Tracé des Freins Hydrauliques). M. Vallier. A discussion of the proper proportions of hydraulic buffing cylinders for the absorption of the recoil force of artillery. 1800 w. Comptes Rendus—Nov. 6. 1899. No. 31016 D.

Impulse Wheels.

An Interesting Water-Wheel Application. Illustrated description of the impulse wheels set up in the force main from a pumping station, to furnish power for electric generation. 600 w. Eng Rec—Nov. 11, 1899. No. 30714.

Piping.

A Proposed Improved System of Hydraulic Piping. Walter Ferris. Illustrates and describes the writer's plan. Part first gives an outline of the scheme. 2500 w. Am Mach—Nov. 2, 1899. Serial. 1st part. No. 30571.

Power Plant.

Two-Phase Water-Power Development at Sherbrooke, Quebec. A brief illustrated description of the electric light and power plant, its power development, its equipment and distribution. 2700 w. Can Elec News—Nov., 1899. No. 30739.

Pressures.

High Hydrostatic Pressures and Their Application to Compressing Liquids; a New Form of Pressure Gauge. Francis H. Stillman. Describes methods and apparatus used. Ill. 2000 w. Trans Am Soc of Mech Engs, No. 848—Dec., 1899. No. 30903 C.

Pressure in Pipe Due to Stoppage of Flowing Liquid. George M. Peck. Discussion of subject. 600 w. Trans Am Soc of Mech Eng, No. 837—Dec., 1899. No. 30892 C.

Pumping Engines.

See Steam Engineering.

Turbines.

The Turbines of the Rheinfelden Power Plant (Die Turbinen der Kraftübertragungswerke Rheinfelden). F. Prásil. Giving details of the construction and arrangement of the triple turbines at Rheinfelden of 840 h. p. each. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1899. No. 31024 D.

MACHINE WORKS AND FOUNDRIES.

Accounting.

An Automatic Cost Distributing and Accounting Plan. W. S. Rogers. Describes the plan as worked out and applied. 3000 w. Ir & Coal Trds Rev—Nov. 10, 1899. No. 30863 A.

Boiler Works.

The Boiler Shops of the Alsace Machine Works at Grafenstaden (Kesselschmiede der Elsässischen Maschinenbaugesellschaft in Grafenstaden). Illustrated description of a modern boiler works with especial reference to electrically operated tools and hydraulic riveting machinery. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1899. No. 31023 D.

Castings.

Casting Axle Boxes, Wheels, etc., on Chills. Walter J. May. Directions for a cheap way of preparing castings for certain applications. 700 w. Prac Engr—Oct. 20, 1899. No. 30529 A.

Skimming Gates. Eli H. Pearce. Suggestions for this work. Ill. 800 w. Foundry—Nov., 1899. No. 30939.

Sweeping a Large Spur Pinion. R. H. Palmer. Illustrated detailed description. 1400 w. Am Mach—Nov. 2, 1899. No. 30572.

Coke Consumption.

Coke Consumption in Iron Foundries. Walter J. May. Considers things affecting the quantity consumed. 1500 w. Prac Engr—Oct. 27, 1899. No. 30635 A.

Crane Beds.

Making Revolving Crane Beds. Joseph Horner. Illustrated description. Am Mach—Nov. 16, 1899. Serial. 1st part. No. 30784.

Cranes.

See Electrical Engineering, Power Applications.

Dividing Engines.

The Wurdemann Automatic Dividing Engine. C. L. Berger. Illustrates and describes an engine for automatically graduating the circles of astronomical and scientific instruments, which is of interest on account of novel features and its remarkable accuracy. 1000 w. Eng News—Nov. 2, 1899. No. 30684.

Drawing.

Parallel Ruler Attachments. William Pilton. Illustrated descriptions. 800 w. Am Mach—Nov. 16, 1899. No. 30785.

Drilling.

A Travelling Drilling Machine. Illustrated description. 500 w. Engr, Lond—Nov. 17, 1899. No. 31105 A.

Fluxes.

The Use of Fluxes in the Foundry. Walter J. May. On the few uses of fluxes and the general ignorance concerning why they are used. 800 w. Prac Engr—Nov. 10, 1899. No. 30869 A.

Flywheels.

A Broken Flywheel and How It Was Repaired. James McBride. Illustrates and describes the wheel and the method of repair which left it stronger than when first erected. 1600 w. Trans Am Soc of Mech Engs, No. 836—Dec., 1899. No. 30891 C.

A Note on Flywheel Designs. A. J. Frith. A study of the effect of the arms of a flywheel on its rim, and regarding the mutual proportions. 1400 w. Trans Am Soc of Mech Engs, No. 832—Dec., 1899. No. 30887 C.

Lamp Factory.

Baerrenberg Incandescent Lamp Factory. A brief illustrated description of works being erected for the manufacture of glow lamps by the Berrenberg process. 1600 w. Elect'n, Lond—Nov. 3, 1899. No. 30778 A.

Lathes.

A Lathe With Some New Features. Illustrates and describes the Le Blond lathe. 1500 w. Am Mach—Nov. 2, 1899. No. 30573.

Heavy Duplex Lathe. Illustrated description of a very powerful lathe for dealing with shafting of the heaviest class. 700 w. Engng—Oct. 27, 1899. No. 30617 A.

Hexagon Turret Lathe. Illustrated detailed description of a fine English tool, exhibited by Alfred Herbert, Ltd., at the Crystal Palace. 5000 w. Engr, Lond—Nov. 17, 1899. No. 31102 A.

Machine Tools.

The Work of Machine Tools. An abridged translation of a paper contributed to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.* An account of investigations of Messrs. F. Hillier and Ch. Frémont. 2500 w. Engr, Lond—Nov. 17, 1899. No. 31106 A.

Manufacturing Plant.

The Works of the Bullock Electric Manufacturing Company. Illustrated description of new shops with electrically driven tools and an unusual system of electric transmission, allowing six changes of speed of tools without changing gears or using resistance. 1800 w. Eng Rec—Nov. 25, 1899. No. 30950.

Molding.

The Poole Molding Machine. Illustrated description of the machine and its work. 1500 w. Foundry—Nov., 1899. No. 30940.

Piecework.

Regarding Piecework. Editorial discussion of the advisability of adopting the piece-work system in railway shops. 1800 w. Ry & Engng Rev—Nov. 11, 1899. No. 30749.

Preston Works.

The Electric Railway and Tramway Carriage Works, Limited, Preston, Eng. Benjamin Sykes. Illustrated detailed description. 2800 w. Elec Eng. Lond—Nov. 10, 1899. No. 30857 A.

Punching.

Indexing Multiple Punching Machine. Illustrates and describes a machine for punching the parts of built-up columns, girders, etc., direct from the drawings and without templates or laying-out of any kind. 2500 w. Am Mach—Nov. 9, 1899. No. 30670.

The Werner Portable Punching and Cutting Machine. Illustrates and describes the machine and the general principle on which it works. 600 w. R R Gaz—Nov. 10, 1899. No. 30738.

Records.

Railway Map and Profile Records. V. K. Hendricks. Describes the practice on the Terre Haute & Logansport Ry., with additional suggestions. 2400 w. Pro of Ill Soc of Engs & Surv—1899. No. 30546 E.

Screw Machine.

Automatic Screw Machine. Illustrates and describes a fine English machine for producing all kinds of pins, collars, studs, washers, bushings, or turned work, and specially suited for the production of projectiles. 2000 w. Engng—Nov. 10, 1899. No. 30875 A.

Screw System.

Report on the Width of Nut for the New Metric Screw System (Bericht über die Frage der Schlüsselweiten zum Neuvem Metrischen Gewinde-System). An appendix to the report of the Zurich conference of 1898, discussing especially the width between opposite flat faces of nuts and bolt heads. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 27, 1899. No. 31020 B.

Shop Practice.

The Revolution in Machine Shop Practice. Henry Roland. A well and richly illustrated exposition of the adaptation of the turret to multiple-production of machine parts, either from the bar or castings, with consequent enormous reduction of costs. 3500 w. Engineering Magazine—Dec. 1899. No. 31093 B.

Shops.

The Shops of the Bethlehem Steel Company. Illustrations and descriptions of some of the notable tools used for machining the forgings. 2000 w. Mach, N. Y.—Nov., 1899. No. 30561.

Slide Rule.

The Slide Rule for Computing Gears for Screw Cutting. J. H. Gill. Describes the writer's way of selecting compound gears for thread cutting. 700 w. Am Mach—Nov. 16, 1899. No. 30786.

Slotting Machine.

Portable Slotting Machine. Illustrated description of an electrically-driven machine. 700 w. Engr, Lond—Nov. 17, 1899. No. 31104 A.

South Africa.

Some Notes on South African Foundries. James Cherrie. An account of a trip, with description of foundry work. 3000 w. Foundry—Nov., 1899. No. 30-941.

Standardizing.

Standardizing in Engineering Construction. Sir B. C. Browne. Shows the fallacy of the labor party's attitude toward economy of production and the dangers of unionism, either of employers or workers; proves the identity of interest of capital and labor in reducing manufacturing cost, and urges co-operation between workmen and employers. 3000 w. Engineering Magazine—Dec., 1899. No. 31095 B.

Stanley Show.

Some Machine Tools at the Stanley Show. Illustrates and describes a variety of automatic machines exhibited. 6000 w. Engr, Lond—Nov. 17, 1899. No. 31103 A.

Swiss Works.

The Engineering Works of Escher, Wyss & Co. Description of works established in the town of Zurich in 1805, and now covering about 35 acres. 3300 w. Engng—Nov. 3, 1899. No. 30751 A.

Taper.

A Standard Taper for Twist Drills and Milling Tool Shanks (Ein Normalsystem für Spiralbohrer und Fräserkegel). H. Pasler. Discussing a proposed system similar to the Morse, for use with metric dimensions. 1800 w. Zeitschr d Ver Deutcher Ing—Nov. 11, 1899. No. 31036 D.

Tools.

An Endshaking Tool. Illustrated description of a tool used in watch-making. 600 w. Am Mach—Nov. 23, 1899. No. 30927.

British and American Machine Tools. Part first is a comparison of the conditions surrounding the trade. 2400 w. Engr, Lond—Oct. 27, 1899. Serial. 1st part. No. 30621 A.

Twist Drills.

The Limiting Size of a Twist Drill. On some experiments made by L. P. Breckinridge in 1888, with comments. Ill. 1000 w. Am Mach—Nov. 23, 1899. No. 30926.

Works Management.

Works Management for the Maximum of Production. J. Slater Lewis. A forcible definition of the practical condition of the British engineering trade, a critical discussion of the arguments for and against specialization and a depreciation of unreasoning extravagance in the campaign for reorganization. 3500 w. Engineering Magazine—Dec., 1899. No. 31092 B.

MATERIALS OF CONSTRUCTION.

Dynamograph.

A Metal Dynamograph. Paul Mellen Chamberlain. Describes this machine for testing cast-iron specimens. Ill. 700 w. Trans Am Soc of Mech Engs, No. 846—Dec., 1899. No. 30901 C.

Grindstones.

Experiments Upon the Strength of Grindstones (Versuche über die Festigkeit von Schleifsteinen). M. Grübler. Especially investigating the resistance of grindstones and emery wheels to the stresses due to centrifugal force, with description of the apparatus and results of tests. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1899. 31031 D.

Impact.

Impact. W. J. Keep. Showing the influence of impact upon test bars of various sizes. 3000 w. Trans Am Soc of Mech Engs, No. 847—Dec., 1899. No. 30902 C.

Preliminary Report on the Present State of Knowledge Concerning Impact Tests. W. Kendrick Hatt and Edgar Marburg. Presented at the annual meeting of the Am. Soc. of the Inter. Assn. for Test. Materials. 7000 w. Assn Bul No. 5—Oct., 1899. No. 30862 D.

Steel Balls.

Strength of Steel Balls. J. F. W. Harris. Gives an account of tests made at the Rose Polytechnic Inst. to determine the breaking strength. 700 w. Trans Am Soc of Mech Engs, No. 844—Dec., 1899. No. 30899 C.

Tensile Tests.

Impact Tensile Tests of Steel. Extracts from the paper of S. Bent Russell, with comments and editorial. 3300 w. Eng News—Nov. 16, 1899. No. 30800.

POWER AND TRANSMISSION.

Air Compressors.

The Intercooler on the Air Compressor. Frank Richards. On the value and efficiency of the intercooler, with suggestions. Ill. 1600 w. Am Mach—Nov. 9, 1899. No. 30671.

Compressed Air.

Compressed Air. J. J. Swann. Discusses the production. transmission and use. 5000 w. Sib Jour of Engng—Nov., 1899. No. 30906 C.

Dumping.

The O'Rourke Dumping Bucket. Illustrated description of a recently patented drop-bottom bucket. 1100 w. R R Gaz—Nov. 24, 1899. No. 30945.

Electric Driving.

See Electrical Engineering, Power Applications.

Factory Transmission.

See Electrical Engineering, Power Applications.

Horse Power.

On the Value of a Horse-Power. George I. Rockwood. Reports the discussion on the question at Worcester, Mass., in settling questions of water privileges. 4800 w. Trans Am Soc of Mech Engs, No. 850—Dec., 1899. No. 30904 C.

Pedal Power.

The Power Transmitted by a Pedal. Adapted from an article in *l'Industrie Velocipédique et Automobile.* Gives experiments and results. 1200 w. Automotor Jour—Nov., 1899. No. 30970 A.

Power Factor.

The Theory of the Power Factor.

Alexander Russell. An investigation attempting to show how the power factor is related to the shape of the waves of current and potential difference, and their relative positions. Mathematical. 1000 w. Elect'n, Lond—Nov. 3, 1899. Serial. 1st part. No. 30779 A.

Transport Appliances.

Mechanical Transport Appliances in Engineering Work. A. J. S. B. Little. A review of the means which reduce greatly the cost of engineering undertakings, either constructive or manufacturing, urging greater attention to their introduction and extension. The illustrations supplement the text by showing many instances of conveyor installations all over the world. 3000 w. Engineering Magazine—Dec., 1899. No. 31096 B.

SPECIAL MOTORS.

Acetylene Motor.

See Automobilism.

Entropy Diagram.

A New Graphical Method of Constructing the Entropy Temperature Diagram of a Gas or Oil Engine from Its Indicator Card. Henry T. Eddy. Explains the method. 2800 w. Trans Am Soc of Mech Engs, No. 831—Dec., 1899. No. 30886 C.

Gas Engines.

A Gas Engine and Fuel-Gas Producer Power Plant. Illustrated detailed description of the plant recently erected at the new shops of the Erie R. R. in Jersey City. 1000 w. Eng News—Nov. 23, 1899. No. 30913.

An Efficiency Test of a One Hundred and Twenty-five Horse-Power Gas Engine. C. H. Robertson. Illustrated description of the plant of the Merchants' Electric Lighting Co., of Lafayette, Ind., with data concerning the performance of the engines. 5000 w. Trans Am Soc of Mech Engs, No. 835—Dec., 1899. No. 30890 C.

Gas Engines and Producer Gas. Reports the results attained at the new power plant of the Erie R. R. at Jersey City, giving an illustrated description of the installation. 2800 w. Am Engr & R R Jour—Nov., 1899. No. 30560 C.

Gas Engine Design. E. W. Roberts. An explanation of the general principles. Ill. 2200 w. Mach, N. Y.—Nov., 1899. Serial. 1st part. No. 30563.

Gasoline.

Gasoline Engines in Pumping Plants. Gives the cost of operation of a number of plants supplying railway divisions. 2000 w. Eng Rec—Nov. 18, 1899. No. 30840.

Kerosene Motor.

See Automobilism.

STEAM ENGINEERING.

Boilers.

Corrosions and Cracks in Locomotive Boilers. Translation of an article by M. Desgeans, in the *Revue Générale des Chemins de Fer.* Illustrated discussions of defects and the causes. 3300 w. R R Gaz—Nov. 3, 1899. No. 30590.

Possible Economies in Steam Boiler Management. Walter B. Snow, in the *Boiler-maker.* Discusses the losses and their causes. 2800 w. Prac Engr—Oct. 27, 1899. No. 30637 A.

Boiler Trials.

Discussions Upon the Provisional and Amended Drafts of the Report of the Committee on the Revision of the Code of 1885, Relative to a Standard Method for Conducting Steam-Boiler Trials. 10800 w. Trans Am Soc of Mech Engs, No. 828—Dec., 1899. No. 30884 C.

Report of the Committee on the Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam-Boiler Trials. Gives the code of 1899 with appendices. 25000 w. Trans Am Soc of Mech Engs, No. 827—Dec., 1899. No. 30883 D.

Chimney.

The Monumental Chimney of the La Bourdonnais Power House (La Cheminée Monumentale de l'Usine La Bourdonnais). G. Leugny. A fully illustrated description of the great chimney for the power-house of the Paris Exposition, with views showing various stages of the work. 2500 w. Revue Technique—Oct. 25, 1899. No. 31017 D.

Coal Calorimetry.

The Berthier Method of Coal Calorimetry. C. V. Kerr. Describes this method, stating its advantages. 2000 w. Trans Am Soc of Mech Engs, No. 841—Dec., 1899. No. 30896 C.

Condensing.

Central Steam Condensing Plants. Considers the advantages and disadvantages as compared with single condensation, and gives detailed description of such plants. Ill. 2800 w. Prac Engr—Oct. 27, 1899. Serial. 1st part. No. 30636 A.

Condensers and Condensing for Electric Power Stations. S. Payne. Read before the Manchester Soc. of Jun. Elec. Engs. Considers the importance of condensing, describing briefly the types of steam condensers and auxiliaries, and the application to electric power stations. 3800 w. Elec Eng, Lond—Nov. 17, 1899. No. 30972 A.

Corliss Engines.

New Corliss Engine for the Boston Elevated Railway Co. Illustrated detailed description. 2800 w. Power—Nov., 1899. No. 30585.

Engine Test.

Test of a Cooper-Corliss Engine at Various Loads. Illustrated report of the efficiency of 1,000 H. P. compound condensing engine under the variable duty of electric railway service. 1300 w. Eng Rec—Nov. 18, 1899. No. 30841.

The Construction and Operation of Corliss Engines. Gives its history and an illustrated description of the machine and its operation. 18800 w. Engr, U. S. A.—Nov. 15, 1899. No. 30962.

The Corliss Engine in Great Britain. Part first gives an account of its pioneers, their work and opposition. Ill. 3300 w. Prac Engr—Oct. 27, 1899. Serial. 1st part. No. 30634 A.

Fuel.

Advantages of Coke Over Coal as a Fuel for Generating Steam. Arthur C. Freeman. Read at Montreal meeting of the New England Cotton Mfrs. Assn. States its advantages and gives suggestions for its management. 1200 w. Am Mfr & Ir Wld—Nov. 9, 1899. No. 30722.

Gas Firing.

Experiments on Using Gasoline Gas for Boiler Heating. Herman Poole. Gives details of experiments made in Philadelphia with a 60 h. p. boiler. 2700 w. Trans Am Soc of Mech Engs, No. 838—Dec., 1899. No. 30893 C.

Heat Transmission.

The Transmission of Heat Through Metals from Steam to Water. A. W. Richter. Illustrated description of tests made to furnish formulas for estimating the transmission of heat in boilers, feed-water heaters, etc. 4000 w. Eng Rec—Nov. 11, 1899. No. 30706.

Improvements.

The Improvement and Development of Boilers and Steam Engines. Thomas Begrie. Abstract of a paper read before the Mech. Engs. Assn., Johannesburg. A discussion of recent improvements and their results. 3000 w. Ir & Coal Trds Rev—Nov. 3, 1899. No. 30767 A.

Indicator Springs.

Testing Indicator Springs. D. S. Jacobus. Describes the method finally adopted for testing indicator springs and obtaining the correct scale to use for a given indicator card. 3500 w. Stevens Ind—Oct., 1899. No. 30557 D.

Liquid Fuel.

Kermode's Apparatus for Burning Liquid Fuel. Describes and illustrates a system where the oil is first vaporized by being mixed with hot air, which is supplied under pressure for the purpose. 1000 w. Engng—Nov. 17, 1899. No. 30984 A.

Mechanical Draft.

The Substitution of Mechanical Appliances for Chimney Draft (Der Ersatz der Dampfschornsteine durch Mechanische Zugmittel). R. Schenkel. With illustrations of numerous devices for producing mechanical draft in steam boiler plants, mainly taken from American practice. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1899. No. 31027 D.

Packings.

Friction of Steam Packings. Charles Henry Benjamin. Describes experiments made at the laboratories of the Case School. Ill. 1500 w. Trans Am Soc of Mech Engs, No. 839—Dec., 1899. No. 30894 C.

Power-House Engines.

The Steam Engine for the Electric-Traction Power-House. C. A. Hague. Displays forcefully the way in which the service differs from mill and marine practice and discusses the changes in design required by the unique and severe conditions. 3000 w. Engineering Magazine—Dec., 1899. No. 31097 B.

Pumping Engine.

Test of the Aurora Pumping Engine. L. P. Breckenridge. Gives method of making the tests and the principal results. 1700 w. Pro of Ill Soc of Engs & Surv—1899. No. 30545 E.

Test of Two Ten-Million-Gallon Pumping Engines at the Baden Pumping Station, St. Louis Water Works, June, 1899. John A. Laird. Illustrated detailed description with results of test. 2400 w. Trans Am Soc of Mech Engs, No. 840—Dec., 1899. No. 30895 C.

Purifier.

Apparatus for Purifying Feed-Water and Heating it to 100° C. (Epurateur Economique Détartrant l'Eau d'Alimentation des Chaudières et la Réchauffant à 100°). A description of the Granddemange heater and purifier; an open pan-heater for use with exhaust steam. 1000 w. Génie Civil—Nov. 4, 1899. No. 31007 D.

Slide Valves.

Friction Tests of a Locomotive Slide Valve. Frank C. Wagner. Describes tests made at the Rose Polytechnic Inst. 900 w. Trans Am Soc of Mech Engs, No. 843—Dec., 1899. No. 30898 C.

Smoke.

The Limits of Economy in Smoke Consumption (Die Kohleersparnis der Rauchverbrennungsanlagen und deren Grenze). E. Nicolaus. An examination of the thermal conditions of smoke consumption, including gas-firing and the use of pulverized fuel. 2000 w. Gesundheits-Ingenieur—Nov. 15, 1899. No. 31043 B.

The Smokeless Combustion of Soft Coal. William Kent. Considers why smoke is produced and the remedy, with an illustrated description of a steam-boiler furnace patented by the writer. 1200 w. Stevens Ind—Oct., 1899. No. 30556 D.

Steam-Dynamo.

Vertical Steam Engine and Dynamo of 3000 h. p. (Stehende Dampfdynamomaschinen von 3000 PS.) A very fully illustrated account of the engines and generators built by Gebrüder Sulzer and the Allgemeine Elektrizitäts Gesellschaft for the Luisenstrasse station at Berlin. 2500 w. 3 plates. Zeitschr d Ver Deutscher Ing—Nov. 4, 1899. No. 31034 D.

Steam Engine.

The Steam Engine at the End of the Nineteenth Century. R. H. Thurston. A scientific study of the machine, presenting data illustrating the approximation attained to the ideal engine of Carnot. Illustrations and plates. 11300 w. Trans Am Soc of Mech Engs, No. 833—Dec., 1899. No. 30888 D.

Steam Turbines.

Presidential Address by the Hon. Charles A. Parsons, before the Institution of Junior Engineers. Dealing largely with steam turbines and their applications. 6000 w. Engr, Lond—Nov. 10, 1899. No. 30867 A.

Superheating.

The Application of Superheated Steam (Die Auwendung des Ueberhitzten Wasserdampfes). H. Hoff. Especially discussing the mechanical arrangements of superheaters of modern types. 1200 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1899. No. 31028 D.

Triple Expansion.

The New 500 h. p. Triple Expansion Engine of the Stockholm Electrical Works (Die Neue 500 Pferdige Dreifach-Expansionsmaschine des Stockholmer Elektrizitätswerkes). S. J. Ledin. A general view of the engine, also detail drawings, and data of tests, with indicator diagrams. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 28, 1899. No. 31033 D.

Turbines.

The Parsons Steam Turbine. An illustrated account of some of the applications of the steam turbine. 1400 w. Sci Am—Nov. 18, 1899. No. 30787.

Valves.

Something About Valves. W. H. Wakeman. Facts from the writer's experience. 1300 w. Am Mach—Nov. 9, 1899. No. 30672.

Vertical Engines.

Engines for the Sheffield Electric Tramways. H. W. Morley. Description, with illustrations, of engines of the slow-speed type. 1500 w. Engr, Lond—Oct. 27, 1899. No. 30622 A.

The Rigidity of Vertical Engines (Die Standfestigkeit der Stehenden Dampfmaschinen). P. Straube. With drawings of numerous forms of framing for vertical engines, comparing their respective advantages. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1899. No. 31030 D.

Water Tubes.

See Marine Engineering.

Winding Engine.

See Mining & Metallurgy, Mining.

MISCELLANY.

Aeronautics.

Count von Zeppellin's Dirigible Airship. Illustrates and describes the structure of this huge airship, being built on a float in Lake Constance. 1200 w. Sci Am Sup—Nov. 11, 1899. No. 30679.

Bicycles.

The Bicycle for War Purposes. B. F. S. Baden-Powell. Discusses its uses, the best type of machine, and the equipment required. Ill. 8000 w. Jour U. S. Art—July-Aug., 1899. No. 30661 D.

The Efficiency of Bicycles. R. C. Carpenter. Discussing the efficiency as a machine, dynamometer tests, etc. Ill. 3000 w. Sib Jour of Engng—Nov., 1899. Serial. 1st part. No. 30907 C.

Blue-Prints.

A Curved Glass Blue-Print Machine. Paul Mellen Chamberlain. Describes and illustrates a convenient machine. 300 w. Trans Am Soc of Mech Engs, No. 842—Dec., 1899. No. 30897 C.

Carbonic Acid.

The Liquefaction of the Carbonic Acid Produced by Breweries and Distilleries (Liquefaction de l'Acide Carbonique des Brasseries et Distilleries d'Alcool). An account of the Meuus method of recovering the waste carbonic acid gas of breweries, etc., and liquefying it for subsequent use. 1000 w. Moniteur Industriel—Nov. 11, 1899. No. 31084 E.

Education.

A Unique Departure in Engineering Education. Edward Orton. An account of the work at the Ohio State University, located at Columbus, Ohio. Ill. 2000 w. Sci Am Sup—Dec. 2, 1899. No. 31114.

Education of Machinists, Foremen, and Mechanical Engineers. M. P. Higgins. Outlines a special school for training.

12500 w. Trans Am Soc of Mech Engs, No. 834—Dec., 1899. No. 30889 D.

The Centennial Celebration of the Technical High School at Berlin (Zur Hundertjahr-Feier der Technischen Hochschule zu Berlin). Giving a history of the institution, with an account of its work and of the notable educators associated with it. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1899. No. 31-029 D.

The Centennial Celebration of the Technical High School at Berlin (Jahrhundertfeier der Technischen Hochschule in Berlin). With the address of the Emperor of Germany, also the speeches at the unveiling of the Krupp and Siemens memorials, and illustrations of the statues. 3000 w. Stahl und Eisen—Nov. 1, 1899. No. 31052 D.

Energy.

Notes on the Commercial Transformation of Energy. Daniel W. Mead. A study of the transmission and transformation of energy. Also discussion. 10-700 w. Pro of Ill Soc of Engs & Surv—1899. No. 30544 E.

Entropy Diagram.

See Special Motors.

Heat.

On "Specific Heat." An explanation, with illustrations. 3800 w. Locomotive—Oct., 1899. No. 30658.

Plow.

The Plow in Asia (La Charrue en Asie). H. Chevalier. A historical study of the development of plowing devices of the East, this paper being devoted to the plow in China and Japan. 1200 w. Génie Civil—Nov. 11, 1899. No. 31008 D.

Rust.

Cases of "Mysterious" Rusting. N. Monroe Hopkins. Describes machines suddenly coated with rust and investigates the causes. 1200 w. Sci Am—Nov. 11, 1899. No. 30677.

Telescope.

The Great Telescope of the Paris Exposition of 1900. Gives views showing the construction, with description. 1800 w. Sci Am—Nov. 4, 1899. No. 30584.

Trade Combinations.

The Strength and Weakness of the Trust Idea. John Graham Brooks. An acknowledgment of the merits which the trust can claim as an aid to organizing industry, and an arraignment of the abuses and evils which attend the craze for combinations. Full publicity and access to information is proposed as a remedy. 4500 w. Engineering Magazine—Dec., 1899. No. 31091 B.

Tuskegee.

Commercial Work by Students of Tuskegee Institute. Harry E. Thomas. An illustrated account of the work at this industrial school for the education of colored youth. 1400 w. Am Mach—Nov. 16, 1899. No. 30783.

Typesetting.

The Lanston Typesetting and Casting Machine. A description, with illustrations, of the character and operation of the Lanston "Monotype" machine. 1800 w. Eng News—Nov. 2, 1899. No. 30688.

Units.

Units of Measurement. W. Moon. A discussion of the systems of mechanical units in use. 700 w. Elec Rev, Lond—Nov. 3, 1899. Serial. 1st part. No. 30-777 A.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

The Examination of Combustibles by the Röntgen Rays (Untersuchung von Brennstoffen Mittels Röntgenstrahlen). F. Kotte. With reproductions of radiographs, showing the manner in which siliceous matter in the carbon is revealed. 1800 w. 2 plates. Stahl und Eisen—Nov. 1, 1899. No. 31055 D.

Coal Working.

Improved Methods of Bringing Down Coal in Prussia. After extracts by *Glückauf*, from the official report. Discusses blasting by mechanical rock-boring, explosives, igniters, etc.; also wedging. 1600 w. Col Guard—Nov. 3, 1899. No. 30761 A.

Improved Methods of Working Coal in Prussia. After extracts by *Glückauf* from the official report for 1898. Illustrates and describes several methods. 1200 w. Col Guard—Nov. 10, 1899. No. 30880 A.

Coke Consumption.

See Mechanical Engineering, Foundries.

Coke Handling.

The Mechanical Handling of Coke (Manutention Mécanique du Coke). J. Laverchère. Giving numerous illustrations of devices for handling gas-works coke, as installed in the United States and in France. 2000 w. 1 plate. Génie Civil—Oct 14, 1899. No. 31000 D.

New Zealand.

Coal Mining in New Zealand. Harrison F. Bulman. On the explosions in the mines, describing the most serious accidents, and giving other information. 1500 w. Col Guard—Nov. 17, 1899. No. 30987 A.

Prospecting.

Prospecting for Coal in Colorado. Arthur Lakes. How to distinguish the strata in which it may be found. Ill. 1900 w. Mines & Min—Nov., 1899. No. 30639 C.

Quenching.

A Dry Quenching Process for Coke. Illustrated description. 900 w. Ir & Coal Trds Rev—Nov. 3, 1899. No. 30766 A.

Separation.

The Separation of Coal and Other Light Minerals. Walter J. May. Describes an arrangement for water separation, and the use of jigging machines. 2000 w. Col Guard—Oct. 27, 1899. No. 30626 A.

Servia.

Coal in Servia. E. Heguer and J. Francois. From a communication to the Société des Ingénieurs des Mines du Hainaut. Descriptive account of the coal-fields and their working. 1100 w. Col Guard—Nov. 17, 1899. No. 30991 A.

South Africa.

The Coal Fields of South Africa. Illustrates and describes the Natal Navigation collieries in part first. 1000 w. Ir & Coal Trds Rev—Oct. 27, 1899. Serial. 1st part. No. 30616 A.

COPPER.

Copper Refining.

The Electrolytic Refining of Copper at Anaconda, Montana. E. C. Sickles. Brief sketch of the general process and the electrolytic refining. 1200 w. Sib Jour of Engng—Nov., 1899. No. 30908 C.

Copper Solutions.

Copper Tubes and Sheets Direct from Solutions. On this method of refining copper and the products obtained. 800 w. Min & Sci Pr—Nov. 18, 1899. No. 30921.

GOLD AND SILVER.

Alaska.

The Cape Nome District, Alaska. Herbert Murray. Information gleaned while prospecting, and from well-informed miners. 1200 w. Eng & Min Jour—Nov. 25, 1899. No. 30958.

British Columbia.

The Atlin District in British Columbia. W. M. Brook. Information concerning this district, taken from the official report. Ill. 1300 w. Eng & Min Jour—Nov. 18, 1899. No. 30804.

The Bridge River Gold Mining Camp. Fritz Cirkel. Read before the Canadian Min. Inst. Describes location, deposits, etc. 3500 w. Can Min Rev—Oct. 31, 1899. No. 30580 B.

California.

The Emerson Shaft of the Wildman Mine, Sutter Creek, Cal. Illustrated description of a plant designed for deep mining. 700 w. Min & Sci Pr—Nov. 18, 1899. No. 30922.

The Vanderbilt Mining District, San Bernardino County, Cal. Report of this district and the peculiar vein system. 1700 w. Min & Sci Pr—Nov. 18, 1899. No. 30923.

Cyanide Plant.

Method of Working at the Taylor Mine Cyanide Plant, El Dorado County, Cal. E. F. Gropello. Illustrated detailed description of the plant and its operation. 1400 w. Min & Sci Pr—Oct. 28, 1899. No. 30581.

Permanganate.

The Permanganate Process of Gold Recovery. Describes this process, but does not think it has any extensive future before it. 900 w. Eng & Min Jour—Nov. 11, 1899. No. 30723.

Placer Deposits.

A Low-Grade Placer Proposition in Montana. Fred D. Smith. An illustrated account of a placer being worked, which yields less than 2c. to the yard. 800 w. Eng & Min Jour—Nov. 11, 1899. No. 30724.

Raven Hill.

Description of Raven Hill, Cripple Creek, and Its Ore Deposits. Arthur Lakes. Some of the peculiarities of the vein as shown in the Elkton mine. 1700 w. Mines & Min—Nov., 1899. No. 30640 C.

Sampling.

Some Notes on Mine Surface Sampling. S. H. Pearce. A discussion of methods used and the difficulties met. 6400 w. Jour Chem & Met Soc of S. Africa—Aug., 1899. No. 30689 E.

Silver Ores.

The Treatment of Dry Silver Ores in South America. A. A. Watson. Describes the methods used in Chili, Peru, and Bolivia. 2000 w. B C Min Rec—Nov., 1899. No. 30795 C.

Stamp Mills.

The "A" Battery Frame for Stamp Mills. Robert W. Barrell. Some of its advantages and a description of the method of constructing it. 1500 w. Mines & Min—Nov., 1899. No. 30645 C.

Transvaal.

Gold Production of Transvaal, 1899. From the London *Economist*. Data respecting the production. 500 w. U. S. Cons Repts, No. 567—Oct. 31, 1899. No. 30538 D.

Utah.

The Silver King Mine and Mill, Utah. H. L. J. Warren. Illustrated description. 1500 w. Eng & Min Jour—Nov. 4, 1899. No. 30596.

Washington.

The Republic Mining Camp, Washington. M. H. Joseph. A description of the country and camp, with historical account. Ill. 3300 w. Eng & Min Jour —Nov. 25, 1899. No. 30956.

IRON AND STEEL.

Blast Furnaces.

On Blast-Furnace Burdens. Walter Macfarlane. Read at the Dudley meeting of the South Staffordshire Iron & Steel Inst. Discusses various problems in the making of pig-iron. 2200 w. Ir & Coal Trds Rev—Nov. 3, 1899. No. 30768 A.

The Iron Making Blast Furnace as an Ideal Power Producer. Horace Allen. The first of a series of articles on the utilization of blast-furnace gases. 600 w. Am Mfr & Ir Wld—Nov. 9, 1899. Serial. 1st part. No. 30720.

Critical Ranges.

The Critical Ranges in Iron and Steel. H. M. Howe. A discussion of points in Mr. Osmond's discussion, with three amendments. 1300 w. Metallographist—Oct., 1899. No. 30815 F.

Cuban Ore.

Cuban Iron Ore. Editorial on a project for establishing an extensive iron and steel plant at Boston for the working of ores from Cuba and Spain. 2500 w. Engr, Lond—Nov. 17, 1899. No. 30999 A.

Hardened Steel.

The Constitution of Hardened Steel. Albert Sauveur. Presents the writer's opinion, which differs from the conclusions reached by Messrs. Arnold and McWilliams. Ill. 2000 w. Metallographist —Oct., 1899. No. 30817 F.

Iron Works.

Sixty Years in the Iron-Works. George Beard. Presidential address delivered to the West of Scotland Iron and Steel Inst. Discusses production, protection, and features of interest. 5300 w. Ir & St Trds Jour—Oct. 28, 1899. No. 30681 A.

Iron Mine.

The Mahoning Iron Mine. An illustrated account of this mine and its working. 1800 w. Ir Age—Nov. 9, 1899. No. 30673.

Iron Trade.

New Phases in the Iron Trade. Charles Kirchhoff. Address before Metal Section of the Manufacturers' Club, Philadelphia. 2500 w. Ir Age—Nov. 16, 1899. No. 30781.

Malleable Iron.

Physical Characteristics of Malleable Cast Iron. Erastus C. Wheeler. Considers the influence of heat conditions, chemical composition, annealing, test bars, etc. 2700 w. Ir Age—Nov. 9, 1899. Serial. 1st part. No. 30674.

Microscopic Analysis.

Practical Microscopic Analysis for Use in Steel Works. C. H. Ridsdale. Abstract of a paper read before the Iron & Steel Inst., of Great Britain. On the value of the microscope from the view of steel makers and users. 9000 w. Eng News—Nov. 2, 1899. No. 30685.

Nickel Steel.

Nickel Steel and Its Uses. R. A. Hadfield. Abstract of paper read before the Inst. of Civ. Engs. Describes several special applications of nickel steel. 3500 w. Ir & Coal Trds Rev—Nov. 17, 1899. No. 30980 A.

The Age of Nickel Steel. Harry J. Williams. Relates the facts concerning armor plate tests in 1890, and the effect on this product, also states its advantages. 2000 w. Ir Age—Nov. 9, 1899. No. 30675.

Open Hearth.

The Use of a Large Proportion of Soft Pig Iron in the Open Hearth Process (Martiniren bei Verwendung eines sehr Hohen Procentsatzes Weichen Roheisens). A. Sattman. A very complete description of an improved basic open-hearth process to be used continuously in direct connection with the blast furnace. 4500 w. Stahl und Eisen—Oct. 15, 1899. No. 31050 D.

Steel Works.

The Saarbrück Steel Works (Saarbrücker Gusstahlwerke). A general description of the works, with views showing the electric power plant and the electric driving. 1500 w. Stahl und Eisen—Nov. 1, 1899. No. 31053 D.

Structural Steel.

The Making of Structural Steel. F. H. Kindl. Read before the Am. Inst. of Archts., at Pittsburg. Describes the operations involved in the manufacture of structural shapes. 4500 w. Ir & Trd Rev—Nov. 16, 1899. No. 30793.

Temperatures.

Colors of Heated Steel Corresponding to Different Degrees of Temperatures. Maunsel White and F. W. Taylor. Notes of value to those handling steel. 500 w. Trans Am Soc of Mech Engs, No. 845—Dec., 1899. No. 30900 C.

On the Influence of Low Temperatures Upon Certain Steels. F. Osmond. A statement of experimental facts and their explanation. 900 w. Metallographist—Oct., 1899. No. 30816 F.

MINING.

Accidents.

Accidents from Falls of Roof and Sides. H. W. Holbaum. Considers the ways of most effectively dealing with this evil, discussing various opinions. 4200 w. Col Guard—Nov. 17, 1899. No. 30989 A.

Blasting.

Blasting in Mines. From *Allgemeine bergmännische Zeitschrift.* Discusses the choice of explosives, arrangement for charges, igniters, etc. 2000 w. Col Guard—Nov. 17, 1899. No. 30988 A.

China.

Boring for Gas and Petroleum in China. From *The Petroleum Industrial and Technical Review.* Information concerning the methods used, the products, and their uses in China. 1300 w. Sci Am Sup—Nov. 18, 1899. No. 30790.

Compass.

The Langer Compass Suspension for Use in the Vicinity of Iron (Das Langer'sche Hängezeng zur Verwendung des Compasses in Gegenwart von Eisen). H. Brathuhn. Illustrating and describing a form of suspension for a mining compass by which the relative deflection due to neighboring masses of iron may be determined. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 28, 1899. No. 31056 B.

Cuba.

Mining Conditions in Cuba. William B. Phillips. Describes the conditions under which mining is at present carried on. 2100 w. Eng & Min Jour—Nov. 25, 1899. No. 30957.

Deep Mining.

Mining at Great Depths. Reviews some of the great depths already reached and discusses proposed work, especially in the Witwatersrand. 1200 w. Engr, Lond—Nov. 3, 1899. No. 30760 A.

Depreciation.

Application of Different Methods of Depreciation to Mining Property. George Johnson. Shows the application of the four principal methods in ordinary use to mining property. 700 w. Col Guard —Nov. 10, 1899. No. 30878 A.

Systems of Recording Different Methods of Depreciation as Applied to Mining Property. George Johnson. Supplementary to a recent paper by the same writer. Describes modes of recording. 500 w. Col Guard—Nov. 17, 1899. No. 30990 A.

Drilling.

Diamond Drilling. H. M. Lane. Recovery of lost-rods, bits, and diamonds, and methods of obtaining cores from soft or soluble material. 2000 w. Mines & Min—Nov., 1899. No. 30642 C.

Speed of Drilling. Alfred C. Lane. Gives a table prepared by W. W. Stockly, with comments. 700 w. Eng & Min Jour —Nov. 4, 1899. No. 30597.

Dynamite.

Conditions for Safely Storing Dynamite in Underground Workings. From a report by M. H. Le Chatelier to the Commission des Substances Explosives, published in the *Annales des Mines.* An account of experiments for studying and determining the conditions. Ill. 2000 w. Col Guard—Oct. 27, 1899. No. 30625 A.

Electric Power.

Electricity in Coal Mining. John Price Jackson and Frank F. Thompson. Considers lighting, haulage, cutting or drilling, pumping and driving fans in soft coal mining. Also discussion. 4000 w. Trans Am Inst of Elec Engs—Oct., 1899. No. 30931 D.

Explosives.

New Home Office Test for High Explosives. Gives an account of a special test proposed in order to assist miners in the selection of a safe explosive for dangerous mines. 1300 w. Ir & Coal Trds Rev—Nov. 17, 1899. No. 30982 A.

Firedamp.

Apparent Cause of Error in Firedamp Determination by the Limits of Inflammability. M. Lebreton. From a communication to the *Annales des Mines.* Discusses the causes of variation. 1200 w. Col Guard—Nov. 3, 1899. No. 30762 A.

Handling.

Appliances for Handling and Storing Coal and Iron-Ore (Technische Hülfsmittel zur Beförderung und Lagerung von Kohlen und Eisenerzen). M. Buhle, With descriptions of numerous forms of conveyors and other handling devices of Continental, English, and American origin. Serial, Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1899. No. 31026 D.

Haulage.

Rope Haulage in Mines. Describes the two systems, the endless rope, and the main and tail. 1500 w. Eng & Min Jour—Nov. 25, 1899. No. 30959.

The Rope Haulage Plant of the Coke Ovens at the Röchling Steel Works at Völklingen, in Altenwald (Die Machinelle Seilförderung auf der im Besitz der Röchlingschen Eisen und Stahlwerke zu Völklingen a. d. Saar Befindlichen Koksofen-Anlage in Altenwald). H.

Weihe. With numerous views showing the arrangement of cables and trackways. 2500 w. Glückauf—Oct. 14, 1899. No. 31059 B.

The Windber, Pa., Electric Haulage Plant. Illustrated description of the equipment and some figures as to operating expenses. 1200 w. Mines & Min—Nov., 1899. No. 30647 C.

Lamps.

A New Safety-Lamp Lock. M. H. Baugniet. From a communication to the Société des Ingenieurs des Mines du Hainaut. Briefly describes and illustrates three systems, investigated because of an explosion, caused by opening a lamp. Favors the Bomal lock, which depends upon a lead rivet. 2200 w. Col Guard—Nov. 17, 1899. No. 30992 A.

Improved Sussmann Lamp at the Strepy-Bracquegnies Collieries. Joseph Goffin. From a communication to Société des Ingenieurs des Mines du Hainaut. An illustrated description of the improved lamp. 1100 w. Col Guard—Nov. 10, 1899. No. 30879 A.

Mining Law.

The Field Mining Law. A new set of regulations that became effective in the State of Washington, June 9, 1899. 1700 w. Mines & Min—Nov., 1899. No. 30643 C.

The Rating of Collieries. Summary of British law and decisions. 3800 w. Col Guard—Nov. 3, 1899. No. 30763 A.

Motive Power.

Motive Power at the Mines. A. E. Chodzko. A discussion of the most desirable methods in the production of motive power at a mine. 1200 w. Min & Sci Pr—Nov. 18, 1899. Serial. 1st part. No. 30924.

Ore Deposits.

An Examination of the Ore Deposits at Rammelsberg near Goslar (Beitrag zur Kenntniss der Erzlagerstätte des Rammelsberges bei Goslar). Dr. Söhle. With geological map and sections showing the deposits of copper, lead, and sulphur, in this important district in Hanover. 3500 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 11, 1899. No. 31058 B.

Peru.

Peru and Its Mineral Wealth. Information from a pamphlet by Ernest Thorndike. 1600 w. Engr, Lond—Nov. 17, 1899. No. 30995 A.

Prospecting.

The Florissant Basin. Arthur Lakes. An account of a prospecting trip in the volcanic region between Cripple Creek and South Park. 2600 w. Mines & Min—Nov., 1899. No. 30644 C.

Rescue Work.

Rescue Work in Mines. Hugo Rössner, in *Oesterreichische Zeitschrift für Berg und Huttenwesen.* An account of the drill given in the use of the apparatus and appliances. 1100 w. Col Guard—Nov. 3, 1899. No. 30765 A.

Road-Making.

Road-Making on Mining Lands. Walter J. May. Some hints on the making of good roads out of available material. 900 w. Col Guard—Nov. 10, 1899. No. 30877 A.

Shaft Sinking.

Sinking a Shaft at the Bois-du-Luc Collieries. Adolphe Demeure. Translated from the *Annales des Mines de Belgique.* Illustrated description of an undertaking where certain improvements were introduced to facilitate operations. 3000 w. Ir & Coal Trds Rev—Nov. 17, 1899. No. 30981 A.

South Africa.

South Africa from an Engineering Standpoint. Albert Williams, Jr. An impartial expert review of the causes leading up to the Boer war, the general conditions under which mining has been conducted, the expansion certain to follow under just and liberal government, and the interest of the engineering world in the newly opening African empire. 4000 w. Engineering Magazine—Dec., 1899. No. 13090 B.

Stoping.

Machine Drills in Stoping. B. L. Thane. An outline of the writer's experience in Alaska, with discussion of the work and its difficulties. 2800 w. Aust Min Stand—Sept. 28, 1899. No. 30676 B.

Surveying.

A Geological Survey of a Mining Property. T. C. Hopkins. The details which must be determined, and how they should be shown on the map and notes. 1800 w. Mines & Min—Nov., 1899. No. 30646 C.

Ventilators.

Comparative Experiments with Capell and Mortier Ventilators at the Bonifacius Mine (Vergleichende Versuche mit Einem Capell und Einem Mortier Ventilator auf Zeche "ver. Bonifacius"). Both fans were electrically driven, and the methods of test are given in detail; also tables of results and graphical diagrams. 4000 w. 2 plates. Glückauf—Oct. 28, 1899. No. 31060 B.

Winding Engine.

The Compound Winding Engine, its Operation and Steam Consumption (Ueber Compound Fördermaschinen, deren Betriebs und Dampfconsumverhältnisse). Julius Divis. A general review of the advantages of the compound engine for mine hoists, giving methods of computing cylinder ratios, and general proportions for this especial service. Serial. Part I. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 4, 1899. No. 31057 B.

MISCELLANY.

Alloys.

Concerning Alloys (Ueber Legirungen). A review of the recent progress of knowledge in the nature of alloys and the manner in which metals unite when fused together. 3500 w. Stahl und Eisen—Oct. 15, 1899. No. 31051 D.

Microstructure of Alloys. J. E. Stead. Considers alloys of antimony and tin, antimony and copper, and copper and tin. Ill. 6000 w. Metallographist—Oct., 1899. No. 30818 F.

On the Dilatation of Metallic Alloys. H. Le Chatelier. Gives results of researches concerning the determination of the dilatation. Ill. 2500 w. Metallographist—Oct., 1899. No. 30819 F.

Corundum.

Notes on the Corundum-Bearing Rocks of Eastern Ontario, Canada. Willet G. Miller. Describes these deposits. 1800 w. Am Geol—Nov., 1899. No. 30979 D.

Diamonds.

The Parent-Rock of the South African Diamond. T. G. Bonney. The substance of a paper, read before the Royal Society, giving an account of investigations made and conclusions reached. 1200 w. Nature—Oct 26, 1899. No. 30613 A.

Education.

Technical Education for Miners in the Wigan District. C. M. Percy. Describes the endeavors to provide education appertaining to mining, in the Wigan coalfield. 2300 w. Col Guard—Nov. 3, 1899. No. 30764 A.

Graphite.

Graphite. J. Ohly. A description of its occurrence and properties. 1200 w. Min Rept—Nov. 2, 1899. Serial. 1st part. No. 30619.

Lead.

A Liquid from the Fumes of Lead Furnaces. Malvern W. Iles. A study of the chemical reactions which take place in the lead blast furnace. 1600 w. Eng & Min Jour—Nov. 11, 1899. No. 30725.

Manganese.

The Manganese Industry in Southern Russia (Ueber die Mangan-Eisen Industrie in Sudrussland). F. W. Lürmann. A brief account of the various works, and statistics of their product from 1893 to 1898. 1800 w. Stahl und Eisen—Oct. 15, 1899. No. 31049 D.

Mica.

The Occurence and Uses of Mica. M. L. Fuller. History of the mining of this mineral in early times, with interesting facts relating to the deposits and uses. 1400 w. Stone—Nov., 1899. No. 31109 C.

Minerals.

The Mineral Industry of Great Britain. Facts given in a series of articles in an English publication form the basis of the information presented. 3200 w. Stone—Nov., 1899. No. 31111 C.

Photography.

Interior Photography. Louis Allen Osborne. The difficulties of photographing interiors of breakers and mills and how they may be overcome. Ill. 3800 w. Mines & Min—Nov., 1899. No. 30638 C.

Rubies.

On a New Mode of Occurrence of Ruby in North Carolina. J. W. Judd and W. E. Hidden. Describes discoveries in the State of North Carolina. Ill. 3800 w. Am Jour of Sci—Nov., 1899. No. 30554 D.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in September. Detailed list and classified summary, with remarks 4400 w. R R Gaz—Nov. 10, 1899. No. 30734.

Austria.

Express Train Speeds in Austria (Schnellzugs-Geschwindigkeiten in Oesterreich). F. Ross. A comparison of the moderate speeds of Austrian express trains with the much higher speeds regularly attained in other parts of Europe and in the United States 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 10, 1899. No. 31022 B.

Employees.

Physical Fitness of Employees. R. C. Richards. Read at meeting of the N. Y. State Assn. of Ry. Surgeons. Gives information obtained from special examinations, with views of the writer. 3800 w. Ry Age—Nov. 24, 1899. No. 30963.

German Trains.

Census of German Express Trains. Information from census made by J. P. Pattinson aiming principally at an estimate of the speed. 300 w. R R Gaz—Nov. 10, 1899. No. 30737.

Railroad Policy.

The Retirement of President Clark. Clarence Deming. Reviews the twelve years during which President C. P. Clark controlled the New York, New Haven and Hartford (Consolidated) Railroad Company, paying tribute also to his fine personality. 1400 w. R R Gaz—Nov. 24, 1899. No. 30943.

Transportation.

American Railroads. George H. Daniels. Address before the International Commercial Congress, at Philadelphia. Discussing their relation to commercial, industrial, and agricultural interests. 3500 w. Sci Am Sup—Nov. 18, 1899. Serial. 1st part. No. 30789.

A Railroad Confession of Faith. Statement submitted by Mr. Paul Morton, of the A., T. & S. F. Ry. to the Industrial Commission in session at Chicago. 2500 w. Ry & Engng Rev—Nov. 25, 1899. No. 31112.

Rail vs. Water Transportation: A Defence of the Latter. Letter from Chauncey N. Dutton, with editorial reply. 3000 w. Eng News—Nov. 23, 1899. No. 30915.

Vision.

Examination for Defects of Vision. Dr. Charles H. Williams. Condensed paper read before the Am. Med. Assn., at Columbus, O. Tests in connection with the semaphore signal are discussed, also color perception tests, and methods used. 3200 w. R R Gaz—Nov. 17, 1899. No. 30805.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Inspection and Maintenance of Air Brakes. Extracts from the report presented at the Nov. meeting of the Central Ry. Club. 900 w. R R Gaz—Nov. 17, 1899. No. 30808.

Armored Trains.

Armor-Protected Troops. Discusses armored trains, armored motor-cars, and coats-of-mail. 2000 w. Engr, Lond—Nov. 3, 1899. No. 30759 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Box Cars.

A Typical Box Car. Extracts from discussion at meeting of the Western Railway Club, on the subject, "What Would Be the Advantage to Railroads in Adopting a Box Car of Typical Inside Dimensions?" 3200 w. R R Gaz—Nov. 24, 1899. No. 30944.

Uniform Dimensions for a Typical Box Car. Discussions by Messrs. A. M. Waitt, and R. P. C. Sanderson. 5000 w. N Y R R Club—Oct. 19, 1899. No. 30882.

Car Temperature.

Automatic Temperature Control for Passenger Cars. Illustrates and describes a modification of the Powers system, which has been tried with success on a number of roads. 1100 w. R R Gaz—Nov. 17, 1899. No. 30806.

Combination Cars.

New 80,000 Lbs. Capacity Combination Coal and Ballast Cars for the Illinois Central. Illustrated description. 800 w. R R Gaz—Nov. 3, 1899. No. 30593.

Couplings.

Double Drawbar Car Couplings. H. M. Lane. Illustrates how they can be arranged to afford safety in hauling trains on steep inclines. 1000 w. Mines & Min—Nov., 1899. No. 30641 C.

The Brockelbank Railway Wagon Coupling. Illustrated description with statement of advantages. 700 w. Engng—Nov. 17, 1899. No. 30986 A.

Electricity vs. Steam.

Electricity versus Steam for Branch Railroad Lines. Charles H. Davis. Continued discussion. 30600 w. Pro Am Soc of Civ Engs—Nov., 1899. No. 30-938 E.

Fireboxes.

Wider Fireboxes. William Forsyth. A discussion of grate area and its relation to cylinder volume. 2000 w. Am Engs & R R Jour—Nov., 1899. No. 30-559 C.

Flanges.

Sharp Flanges—Their Causes and Remedies. C. C. Borton. Extracts from a paper read before the Pacific Coast Ry. Club. Discusses faults in car construction that produce flange wear. 1400 w. R R Gaz—Nov. 3, 1899. No. 30589.

Locomotive Construction.

The Working Stress of Materials Used in British Locomotive Construction. F. W. Jennings. Read before the North-east Coast Inst. of Engs. & Shipbuilders. An investigation of the stresses usually allowed on some of the more important parts of the locomotive. 3500 w. Engng—Nov. 10, 1899. No. 30876 A.

Locomotives.

American Tank Locomotives for Foreign Railways. Illustrates and describes two types of engines rarely used in American practice. 1400 w. Eng News—Nov. 16, 1899. No. 30801.

Baldwin Six Coupled Locomotive—Cambria Steel Co. Illustrates and describes a handsome modern switching locomotive. 500 w. Ry & Engng Rev—Nov. 18, 1899. No. 30851.

Double End Consolidation Locomotive—Dominion Coal Co. Illustrated description of an engine built at the Schenectady Locomotive Works, and sent to Cape Breton, Nova Scotia. 700 w. Ry & Engng Rev—Nov. 4, 1899. No. 30668.

Eight Coupled Tank Locomotive—Port Talbot Railway and Dock Co. Illustrated description of a locomotive for South Wales. 700 w. Ry & Engng Rev—Nov. 25, 1899. No. 31113.

Locomotives for the Southern Railway of France. Considers in some detail the several most advanced types of locomotives that have been brought into service by this company, giving illustrations. 2700 w. Engng—Nov. 10, 1899. No. 30874 A.

Locomotive Tank Engines. Illustration and specifications of one of two tank engines built for the Central London Ry. 1800 w. Engr, Lond—Nov. 17, 1899. No. 30997 A.

Some Deductions from Road Tests of Locomotives. R. P. C. Sanderson. Calls attention to some of the causes which may seriously affect the results of road tests and lead to erroneous conclusions. Discussion. 10000 w. N Y R R Club—Sept. 21, 1899. No. 30750.

Ten-Wheel Express Locomotive for the North-Eastern Railway, England. Elevation and plan, with dimensions and description. Also editorial. 1000 w. R R Gaz—Nov. 10, 1899. No. 30735.

Ten-Wheel Passenger Locomotives. W. H. Marshall's design for use on the Lake Shore & Michigan Southern Ry. is described and illustrated. 1200 w. Am Engr & R R Jour—Nov., 1899. No. 30558 C.

The Heaviest Passenger Locomotive Ever Built, L. S. & M. S. Ry. Illustrated description, with dimensions and comments. Also table. 1300 w. Eng News—Nov. 9, 1899. No. 30694.

Paints.

Durability of Different Colors of Paints for Passenger and Freight Equipment. T. S. Lloyd. Read before the South & Southwest Railway Club. Considers yellow (or orange), Tuscan red and Pullman color. 1500 w. R R Car Jour—Nov., 1899. No. 30746.

Signaling.

Automatic Signaling and Stopping of Trains at Grade Crossings. Illustrated description of an interlocking plant with automatic signals, supplemented on one line by the Rowell-Potter safety stop for automatically applying the brakes should a train try to run past a signal. 1000 w. Eng News—Nov. 16, 1899. No. 30802.

Automatic Signals; Normal Safety or Normal Danger. A. J. Wilson. Presented at Boston meeting of the Railway Signaling Club. Favors the normal danger system as more economical in operation. 600 w. Eng News—Nov. 9, 1899. No. 30699.

Mechanical Fog Signaling Apparatus. Describes a system invented by V. L. Raven and Charles Baister. Ill. 3300 w. Engr, Lond—Nov. 10, 1899. No. 30865 A.

Possibilities of Three-Position Signalling. Frank Rhea. Condensed from a paper presented at Boston meeting of the Railway Signal Club. Discusses the possibilities of three-position signals used with an automatic block system, and with interlocking. 1100 w. Eng News—Nov. 16, 1899. No. 30797.

Progress in Signalling. H. M. Sperry. Prepared for the Boston meeting of the Railway Signalling Club. Review of improvements and advances. 1100 w. R R Gaz—Nov. 3, 1899. No. 30591.

Stability.

Stability of Motion of Vehicles. Discusses the disturbing causes affecting the motion of railroad cars. 1500 w. R R Car Jour—Nov., 1899. No. 30745.

Train.

A Handsome Train. Describes a train soon to be placed on the Chicago & Alton Ry., between Chicago and St. Louis, for a daylight limited service. 800 w. Ry & Engng Rev—Nov. 18, 1899. No. 30850.

Train Lighting.

The Dick System for Electric Train Lighting (Emil Dick's Anordnung für Elektrische Zugbeleuchtung). L. Kohlfürst. The lamps are supplied from accumulators in the respective cars, the accumulators being charged from a dynamo attached to the axle of the baggage car. 3000 w. Schweizerische Bauzeitung—Oct. 21, 1899. No. 31044 B.

Trucks.

Transporting Trucks (Trucks-Transporteurs). M. Claise. Illustrated description of the independent trucks used on the Ardennes narrow-gauge railway for the transport of pieces for which the cars are unsuited. 10000 w. 1 plate. Ann des Ponts et Chausées, 2 Trimestre, 1899. No. 31080 E + F.

NEW PROJECTS

Anatolia.

Germany's Survey for the Bagdad Railway. Brief account of the route being investigated. 700 w. Engr, Lond—Oct, 27, 1899. No. 30624 A.

Mont Blanc.

A Railway Up Mount Blanc. A report made by a scientific commission upon the suggested railway. Translated from *La Revue Alpine*. 2000 w. Engr, Lond—Nov. 17, 1899. No. 31100 A.

New South Wales.

The Railways of New South Wales. Extracts from a recently published review giving information of the progress during the last ten years. Ill. 1000 w. Ry Age—Nov. 24, 1899. No. 30964.

Scotland.

The Invergarry and Fort Augustus Railway. Describes the route and construction of this line. Map. 2000 w. Engr, Lond—Nov. 17, 1899. No. 30993 A.

PERMANENT WAY AND FIXTURES.

Early Construction.

Early Railway Construction in the United States. Abstract from "Poor's Manual," reviewing the railway system from its beginning in 1828. 2200 w. Eng News—Nov. 9. 1899. No. 30695.

Cross Ties.

Steel Ties on the Sumatra State Railways. Information from the report made by L. K. Lindhout, and printed in the Bulletin of the International Railway Congress. 1300 w. Eng. News—Nov. 23, 1899. No. 30917.

The Crosstie Situation. Editorial on the use of metal ties and other materials. 1200 w. R R Gaz—Nov. 17, 1899. No. 30807.

Grades.

Grade Reductions on the Illinois Central in Tennessee. Information relating to work between Fulton, Ky., and Memphis, Tenn. Map and Ills. 800 w. Ry & Engng Rev—Nov. 18, 1899. No. 30849.

Paris.

The Prolongation of the Orleans Railway (Prolongement de la Ligne d'Orléans). Alfred Boudon. A fully illustrated account of the present state of the works, showing the construction of the subway along the Seine, and the terminal on the Quai d'Orsay. 3000 w. Génie Civil—Oct. 28, 1899. No. 31003 D.

Single Rail.

Behr's Single-Rail High-Speed Railway (Ueber Behr's Einschienbahn und Hohe Schnellzug-Geschwindigkeiten). Rolf Sanzin. A discussion of the single rail high-speed road proposed by Behr for use between Liverpool and Manchester. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 20. 1899. No. 31018 B.

Station.

A New Union Station at Richmond, Va. Illustration and plans are given, with brief description of the proposed building. 600 w. Ry Age—Nov. 3, 1899. No. 30609.

Station Grounds.

The Embellishment of Railroad Station Grounds. A. Reinisch. On the treatment such grounds should receive. 1500 w. R R Gaz—Nov. 3, 1899 No. 30592.

Terminal.

Western Railway of Alabama Terminal Improvements, at Montgomery. Ala. Plans and illustration, with brief description. 900 w. Ry & Engng Rev—Nov. 11, 1899. No. 30747.

Tunnel.

See Civil Engineering, Construction.

Track Thrower.

The Creese Track Thrower. Illustrates and describes a recently invented machine and its operation. 500 w. Ry & Engng Rev—Oct. 28, 1899. No. 30537.

TRAFFIC.

Haulage.

Economical Haulage. Editorial discussion of American practice as compared with English. 2000 w. Engr, Lond—Nov. 17. 1899. No. 30998 A.

Trainloads.

What Do We Mean by a Trainload? Editorial discussion of the misleading use of this term. 1500 w. R R Gaz—Nov. 3, 1899. No. 30594.

STREET AND ELECTRIC TRAMWAYS

Brake.

Compressed Air Brake for Electric Tramways (Frein à Air Comprimé pour Voitures de Tramways Electriques). An illustrated description of the standard air brakes, as applied on the electric tramway operated by the *Chemin de fer de l'Ouest,* between the Invalides and Versailles. 1800 w. L'Electricien—Nov. 4, 1899. No. 31087 B.

Cable.

Swansea Constitution Hill Tramway. Illustrates and describes an interesting little cable tramway, where the cable is not continuous, but is attached at either end to a car. 1000 w. Tram & Ry Wld—Nov. 2, 1899. No. 30813 A.

Central America.

An Electric Railway in Central America. Dan Wells Casement. Illustrated detailed description of the equipment of the road at San José, Costa Rica. 1200 w. Am Elect'n—Nov., 1899. No. 30599.

Contact System.

Anderson's Surface Contact Tramway System. Illustrated description of the apparatus and statement of the operation. 2200 w. Tram & Ry Wld—Nov. 2, 1899. No. 30814 A.

Detroit.

Detroit's Effort to Own Her Street Railways. Edward W. Bemis. Gives the history of the street railways and the movement for municipal ownership. 7500 w. Munic Affairs—Sept., 1899. No. 30683 C.

Electrolysis.

Electrolysis—From the Standpoint of the Municipal Electrician. H. S. Wynkoop. Read before the Am. Soc. of Munic. Imp. States the conditions in Brooklyn, and the attitude of the municipality. 2000 w. Munic Engng—Nov., 1899. No. 30575 C.

France.

The Development of the Tramways of France (L'Exploitation des Tramways en France). Charles Jean. A tabulated view, showing the costs of installation and operation for the various kinds of tramway traction now in operation in France. Serial. Part I. 3000 w. Génie Civil—Nov. 4, 1899. No. 31005 D.

Great Britain.

Electric Tramways and British Industry. Hawthorne Hill. On the obstacles met in England by electric railway companies, and their effect on the industrial situation. 1400 w. Ir Age—Nov. 23, 1899. No. 30909.

Java.

Electric Traction in Java. An illustrated description of a new tramway in Batavia, taken from *Elektrotechnische Zeitschrift*. 1000 w. Elec Eng, Lond—Nov. 17, 1899. Serial. 1st part. No. 30971 A.

The Electric Tramway in Batavia (Die Elektrische Strassenbahn in Batavia). An excellent account of this overhead trolley line, the first in the Dutch West Indies, with numerous illustrations. 4500 w. Elektrotech Zeitschr—Oct. 26, 1899. No. 31067 B.

Power House Engines.

See Mechanical Engineering, Steam Engineering.

Rapid Transit.

The Contract for the New York Rapid Transit Railway. An editorial summary of the conditions under which it is proposed to carry out this work. 2000 w. Eng News—Nov. 23, 1899. No. 30914.

Sheffield.

The Sheffield Corporation Tramways. Illustrated detailed description. 3500 w. Tram & Ry Wld—Nov. 2, 1899. No. 30812 A.

Track.

A Novelty in Street Railway Track. Describes a track with 60 ft., 57 lb., T rails, supported at the joints by inverted pieces of the same section riveted base to base. The rails are laid on longitudinal beams of concrete. 600 w. Eng Rec—Nov. 11, 1899. No. 30704.

The Construction and Maintenance of Street Tracks. Describes the work in Kansas City, which has the rails supported on longitudinal beams of concrete. 1800 w. Eng Rec—Nov. 11, 1899. No. 30709.

Track Construction Used in Scranton, Pa. Frank Silliman, Jr. Read before the Penn. St. Ry. Assn. Illustrated description. 700 w. St Ry Rev—Nov. 15, 1899.—No. 30871 C.

Trucks.

Car Trucks. W. H. Heulings, Jr. Read at the Lancaster meeting of the Penn. St. Ry. Assn. Favors the use of the maximum traction truck. 4200 w. St Ry Rev—Nov. 15, 1899. No. 30870 C.

THE
ENGINEERING MAGAZINE
VOL. XVIII. FEBRUARY, 1900. No. 5.

THE ECONOMIC CONQUEST OF AFRICA.

By H. G. Prout.

TO forecast the future of Africa I start with the assumption that the war will end in a peace dictated on England's terms. Setting aside the possibility of interference by continental Powers, there can be no other result. It would be superfluous to dwell upon the difference in war strength between the British Empire and a little inland State with 17,000 voters, even when that little State is helped by another little inland State and by some uprising of Dutchmen and half-breeds along the northern frontier of Cape Colony; if England were to choose to wear these people out by campaigns of attrition, avoiding heavy and bloody engagements, she could no doubt do it. It is evident, however, that she will choose a speedier course, involving more loss of life at the outset, but probably cheaper in the end. The disparity in mechanical skill and efficiency of the two peoples would settle the question if other things were near equal. Doubtless the German artillerists have made good gunners of some of these Boers and very possibly they have developed among them some fairly skillful subordinate artillery officers, but in the nature of things the number of men so trained by the Germans must be very small, and the same must be true of ordnance officers and of

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Whatever the gloom of the present, far-seeing men will share Col. Prout's unshaken faith in the ultimate triumph of just and liberal government in Africa. And history shows that war is followed by periods of great prosperity. So it was with the United States after the Civil war, and more recently after the Spanish-American war; so it was in Ger-

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all those whose business it is to provide and care for ordnance and quartermasters' stores. But England completely controls the seas and the Boers cannot get in any new material. Therefore, as the material now collected is used up, and as the guns are disabled and as the trained artillerists are killed, the disparity between the combatants becomes greater.

We cannot stop now to analyze the military situation, but it may be well to say a word about a fallacy which seems to affect the notions of even intelligent people as to the outcome of this war. It is often said that England has fought no white men since the Crimea. What of that? For generations she has been engaged in incessant wars and oftentimes in desperate, although little, wars. Probably there is no other nation of whose officers and men so great a proportion has seen actual war. All of the older officers have had war after war. Many of the subalterns have made more than one campaign, as has a great proportion of the rank and file. This is not true of any continental army. The English are the most martial people now

PRIMITIVE TRAVEL IN SOUTH AFRICA. AN OX TEAM.

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many and in France after 1871. So it may be expected to prove, both in England and in Africa, with the close of the present struggle.

Col. Prout's long service with Gordon gave him an intimate knowledge of the resources and needs of Northern Africa. His authority as an expert in railway matters is everywhere known.

Recent articles in THE ENGINEERING MAGAZINE dealing with other aspects of the South African situation were:

The Transvaal Mines and the Boer Government. Dr. F. H. Hatch. Aug., 1899.
South African Questions from an Engineering Standpoint. Albert Williams, Jr. Dec., 1899.
John Hays Hammond on the South African Situation. Charles Buxton Going. Jan., 1900.

BRIDGE ON AN AFRICAN CARAVAN ROUTE.

walking about the face of this planet. They have had more fighting per man than any other people, and a great deal of their fighting has been with brave and stubborn, even if barbaric foes. There are few military incidents in the history of mankind so astonishing and so magnificent as the suppression of the Indian revolt of 1857. The breed that did that can be depended upon against any foe.

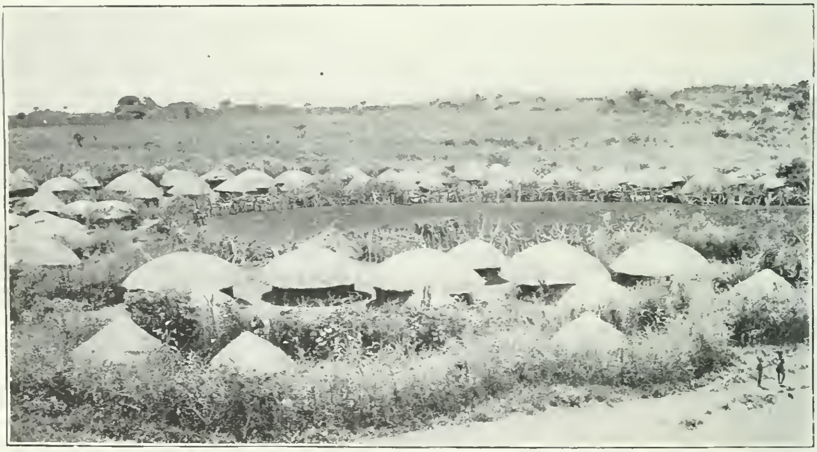
It is inconceivable that any of the European Powers should interfere. Interference would be too costly for the possible gain. It is possible that this war was precipitated to prevent such diplomatic entanglements as would have made one or more of the continental Powers the ally of the Boers in case of the war. This is the opinion of men expert in world politics, but that phase of the matter is past and that peril no longer stands.

What will England's terms be? Obviously, the Orange Free State and the Dutch Republic will cease to exist. Hereafter they can be only British colonies. It seems hardly worth while to go into the ethics of this matter. Whatever may be the right or wrong of the case, discussion of it is now in vain, except in so far as such discussion may help to build up moral sense among the peoples. The war has come, the outcome of it seems inevitable and the right and wrong has passed into the list of questions to be considered by historians and moralists. In passing, however, I will venture to quote a short paragraph from a manuscript document prepared by Chinese Gordon on the subject of the Egyptian advance into the country at the head of the Nile: "Whether a nation has the right to ad-

DUTCH TRADERS BUYING IVORY.

vance and annex the states of other peoples is a question solved by us practically. It can be theoretically discussed and decided on as unjust, but it is acted on practically in a different way." Surely Gordon was a man of a lively and exacting conscience. But he was also a man of a clear mind and of large observation of human affairs.

The struggle now going on in South Africa is merely one phase of the great race movement. It is a part of the ancient historical struggle to partition out the face of the earth. The continent of Africa must be divided up among the white peoples. The black and brown peoples who now occupy the continent belong to those inferior races which, in the struggle for existence, have to go to the wall. The question then is: How shall the continent be divided, and what white nations will possess it?



A KAFFIR KRAAL.

England occupies now the territory from the Cape to the south end of Lake Tanganyika—about 28 degrees of latitude. Within this territory are the South African Republic and the Orange Free State, which will henceforth be British. From latitude 25 south to latitude 11 south, England is shut off from the Indian Ocean by Portuguese East Africa, but south of that she has the coast line all the way around the Cape, and so up on the west side to about latitude 28. Obviously, to make this part of the British possessions most readily available for conquest and exploitation, England should have all of the Portuguese territory, and I take it that she will have this sooner or later. It may not come about by direct purchase, for the Portuguese are vain and impractical. It is possible that the wedge will be entered in the form

GENERAL VIEW OF CAPE TOWN.

CAPE TOWN. THE VICTORIA ROAD.

of a leasehold of the ports, which, after all, would answer England's purposes. Going farther north, German East Africa and the Congo Free State cut the British possessions in two for about 6 degrees or latitude, and then we come to British East Africa, as it is called, which includes the ancient kingdoms of Uganda and Unyoro, and all the country of the White Nile and the Gazelle River, to the tenth degree of north latitude. Then we get to the Egyptian Soudan, but Egypt and all the Egyptian Soudan have now become practically British colonies.

THE PARLIAMENT HOUSES, CAPE TOWN

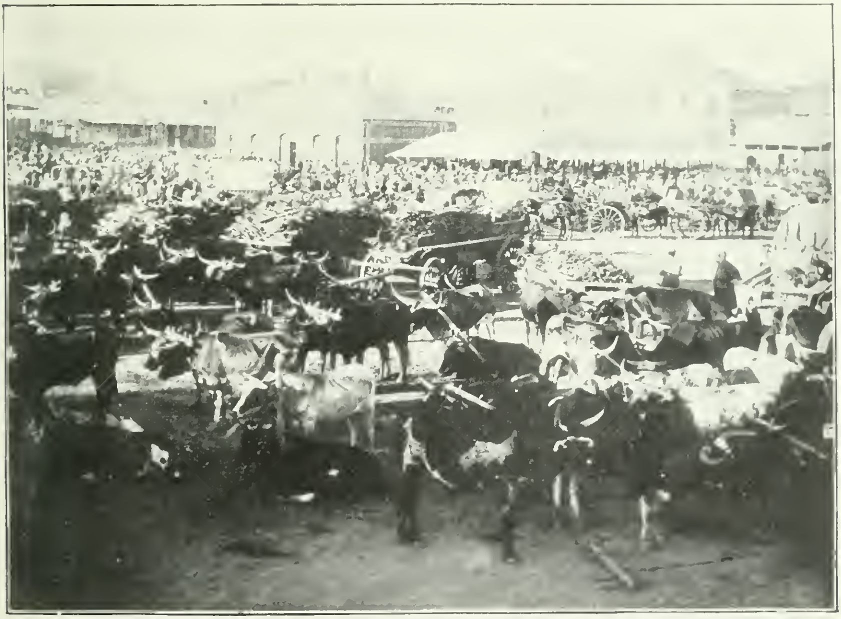
So England has a strip of Africa from the mouth of the Nile at the Mediterranean Sea the whole length of the continent to Cape Town, except the interruption of 5 degrees of latitude about the south side of Lake Victoria and including Lake Tanganyika. On the west coast she has the Niger territories of indefinite extent, including the mouth of the Niger and all the lower reaches of that stream. The British territories, including Egypt, the Egyptian Soudan, the South African Republic and the Orange Free State, will aggregate possibly 3,700,000 square miles.

The Germans control an area fronting on the Indian Ocean, extending inland to Lake Tanganyika and covering about 10 degrees of latitude. They have also on the west coast what is known as German Southwest Africa, covering about 9 degrees of latitude; in all

925,000 square miles. The French claim the Western Sahara, certain territory on the Mediterranean, and the valley of the Senegal and the upper part of the Niger. The Portuguese claim, besides Portuguese East Africa, a territory on the west coast known as Angola. Italy has a precarious holding on the Red Sea and the Indian Ocean, and Spain has a little more than 200,000 square miles in the northwest. According to Mr. Scott-Keltie, Secretary of the Royal Geographical Society, the holdings in square miles of the various European Powers are as follows:

France	3,300,000
Great Britain	2,300,000
Germany	925,000
Congo Free State	900,000
Portugal	750,000
Italy	420,000
Spain	214,000
Boer Republics	168,000

This leaves about 2,900,000 square miles occupied by negroes and Arabs. But to England's holdings we should add Egypt and the Egyptian Soudan and the Boer Republics; so that England is, by all odds, the greatest land-holder in Africa, although in Mr. Scott-Keltie's table France appears as such. If one will look at a good map, how-



THE MORNING MARKET, KIMBERLEY

SOUTH AFRICAN LOCAL TRANSPORT. STEAM TRAM AT THE DE BEERS MINES.

ever, he will see that as Lord Salisbury said, the French African territory is mostly very light soil. England's holdings cover all that is best in Africa, except a little strip along the Mediterranean and possibly German Southwest Africa.

These empires into which the Powers have divided the Continent

ZULU HUTS AT THE KIMBERLEY DIAMOND MINES.

of Africa are mostly inaccessible for commerce or industry. The cost in time and money and the danger to life are too great for anyone to go into them, except for war, or sport, or religion; and before we speak of the possible future of Africa we should consider how we are to get there.

The Cape-to-Cairo Railroad is a good deal in the public mind and is much talked of in a taken-for-granted way, and it would be well to speak of that first, especially as a discussion of this project brings out the natural line of attack on the Continent. Henry Stanley, writing a few months ago, said: "The Cape-to-Cairo Railway, which some appear to think is improbable, will be an accomplished fact before 1925, I believe." Now I do not believe it will, nor do I believe that Cecil Rhodes himself believes it will, nor do I believe that Cecil Rhodes has any notion of building a continuous line of railroad from the Cape to Cairo. It is inconceivable that he should be so injudicious. The total line would be about 5,600 miles, as well as we can tell by scaling off the distances on the best maps. Accurate measurements have been made of about two-fifths of this distance—from Alexandria to Khartoum and from Cape Town to Bulawayo. The intervening distance, about 3,300 miles, has been roughly meas-

RICKSHAW STAND, DURBAN, NATAL.

ured by the itineraries of travelers, but these are only coarse approximations. From Cape Town to Bulawayo is 1,360 miles, and here a railroad is built already. From Bulawayo north to the Zambezi River is perhaps 300 or 350 miles, and Mr. Rhodes has already financed this extension. Very likely it will be built at once after the war ends. From the Zambezi to the south end of Lake Tanganyika is 450 or 500 miles. The lake itself is about 400 miles long; then there is about 300 miles to the Albert Nyanza by land; then something like 200 miles of navigable water the length of the Albert Nyanza and in the upper part of the Nile as far as Dufli; then there is about 125 miles of rapids and obstructed river; then 1,000 miles of river from Lado in the fifth degree of north latitude to Khartoum, and then we come to the Sirdar's military railroad. If we want a through line of steam communication overland from the Mediterranean to the Cape of Good Hope, we could save about 1,600 miles of railroad by using the Nile and the lakes. We should save, not only the interest on the cost of building this 1,600 miles of railroad, but a large part of the cost of maintenance and of operation.

THE CASTLE HOTEL, HOWICK, NATAL.

The reasons for building a railroad along this 1,600 miles of waterway would be the gain of time and the avoidance of transship-

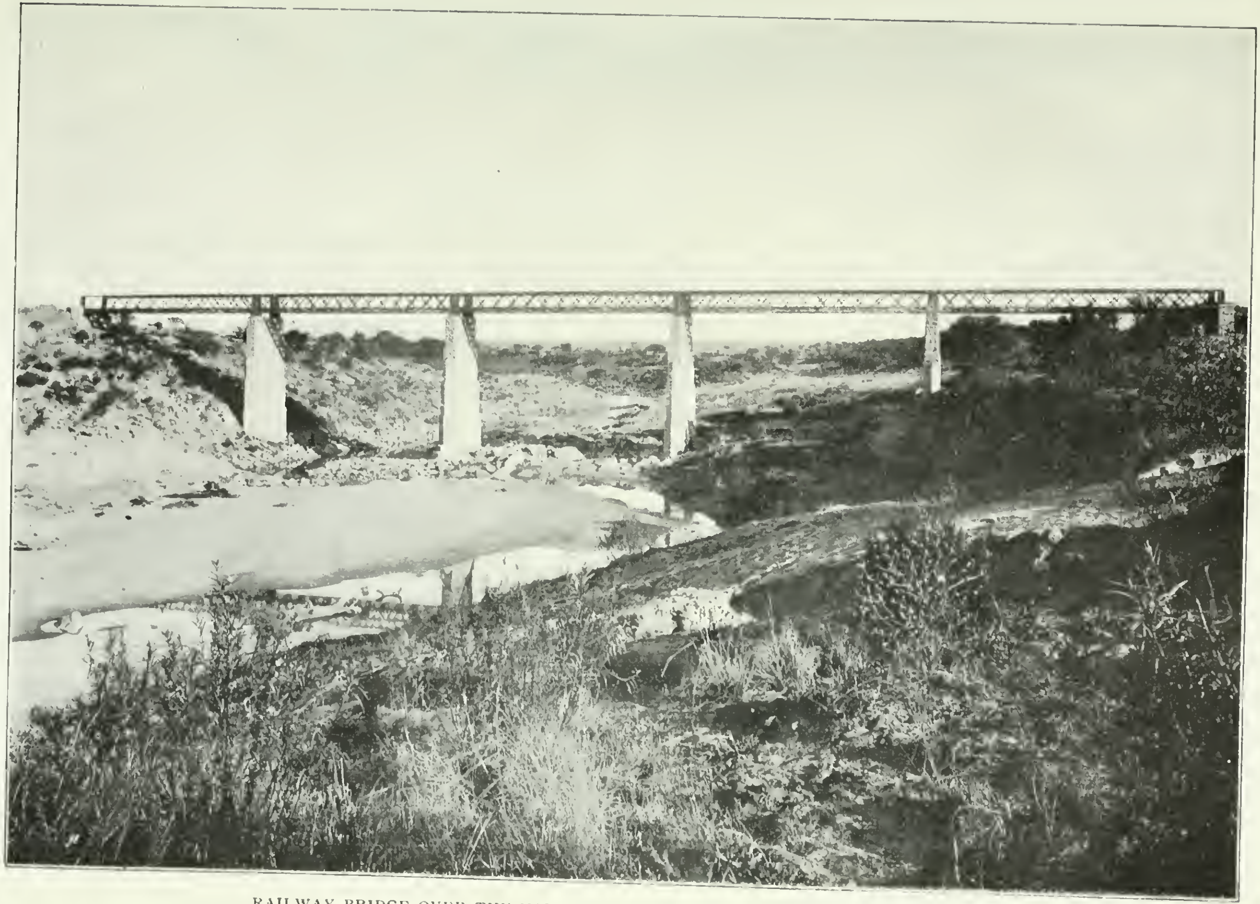
HOWICK WATERFALL, 308 FT. SHEER DROP.
Just north of Pietermaritzburg, Natal.

ment of freight. If we used a combined rail and water way, we should be obliged to transfer from rail to boat, or boat to rail, at Khartoum, at Lado, at Dufli, at the south end of the Albert Nyanza, at the north end of Tanganyika and at the south end of Tanganyika, namely, six times. But why not? The through traffic carried over such a route could be only the very small amount of costly commodities able to stand the freight rate which it would be necessary to charge. Some gold might go this way, some diamonds, a little ivory, and a few ostrich feathers, although it is hard to see why even these commodities should not seek the nearest seaport. No staples could pay the cost of through carriage by this route so long as the oceans exist.

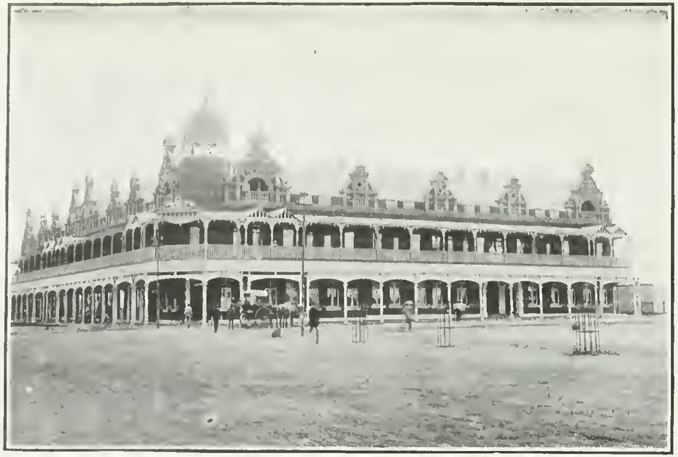
This through line, whether all rail or river and rail, must compete with the Red Sea and the Indian Ocean on one side and the Atlantic on the other. The local traffic would be only such as would come from the production and the needs of a thin population of savages and from the small needs of the military posts. It is possible to imagine a freight movement equal to one freight car a day over any part of the line between Khartoum and the Zambezi, or about 2,500 miles; it is difficult to imagine more than this.

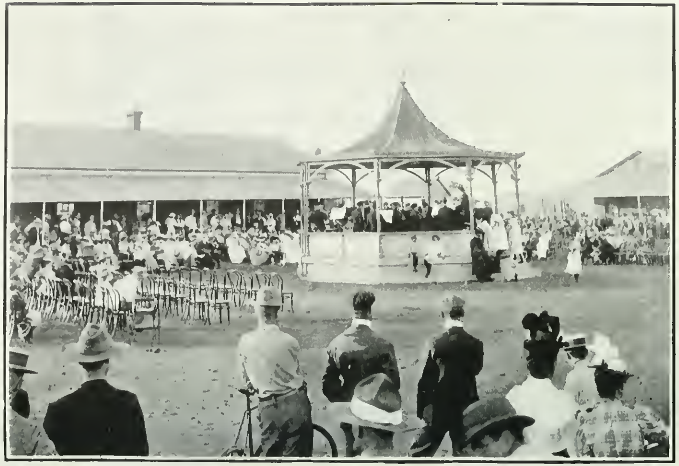
COACH CROSSING THE CROCODILE RIVER, PRETORIA, ON THE BULAWAYO ROAD.
The road crosses the river, called also the Limpopo, at Rhodes' Drift.

The obvious method of attacking all of East Africa is from the Red Sea and the Indian Ocean by building in spurs of railroad. For instance, a railroad will no doubt be built within a few years from Suakim, on the Red Sea, over to the Nile, about 240 miles, by the shortest route—or perhaps 275 to Khartoum. Some day a short railroad may be built from Massaua into Abyssinia and another one from a port of British Somaliland. A railroad is now actually building from Mombasa through British East Africa to the Victoria Lake. Probably the Germans will push in a railroad sometime from near

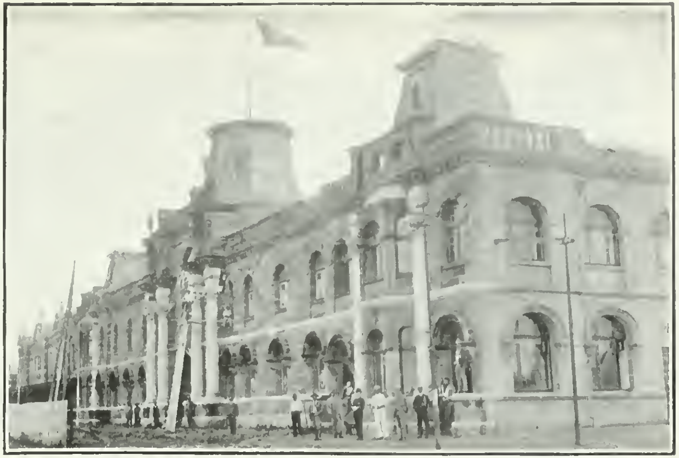


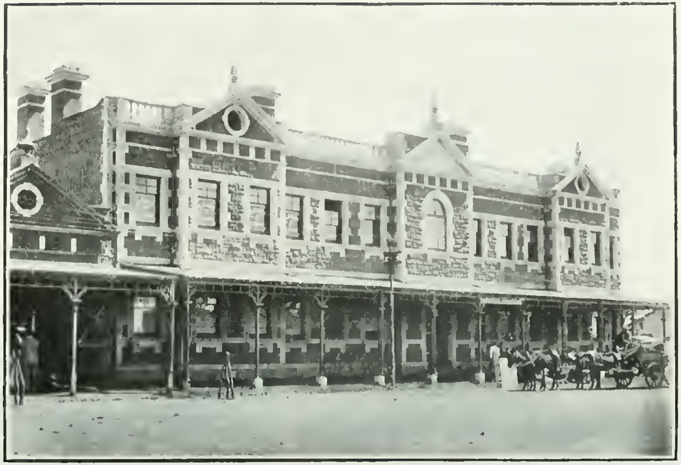
RAILWAY BRIDGE OVER THE VALSCH RIVER, KROONSTAD, ORANGE FREE STATE.





The Grand Hotel.
The Band Stand.





Agency Chambers.
Imperial Buildings.

GLIMPSES OF BULAWAYO, MATABELELAND.

Zanzibar. There is already a short railroad from Beira, in Portuguese East Africa, and that will doubtless be extended to Salisbury in Rhodesia. There is a railroad from Delagoa Bay to Pretoria, and several others have already been built in from various ports on the British South African coast. Such, then, is the obvious development of the attack on Africa all the way from Alexandria to Cape Town.

On the west coast the situation is less obvious. In the northwest there is a vast region in which the French talk of building railroads, but which is really not worth occupation. But as we go southward there are various points of attack by short lines run in from the ocean when the time comes.

A FLEET OF HOUSE CANOES AT ISANGI, ON THE CONGO.

My proposition, in general, is that the economical and efficient way of opening this continent is by short lines from bases on the coast, and this proposition seems so obvious that it is hardly worth while to discuss it. Unfortunately, Africa is singularly lacking in good natural harbors; yet there are enough harbors, and good ones enough, for her needs for some generations to come. Further, the attack of a barbarous and even savage continent, thinly peopled and most unhealthful, by long transcontinental railroads, either north or south, or east and west, is not merely unscientific, but visionary.

But is the continent worth conquest and occupation by white men? Unquestionably, parts of it are. As the years go by and the world becomes more crowded, parts of Africa now not worth occupation will be valuable, and even to-day considerable areas are worth the white man's while. These are already mostly under British control. Mr. Stead has said, "everything in Africa that pays dividends lies within the sphere pegged out for John Bull by his adventurous sons. Wherever in Africa you find land in which white-skinned children can be bred and reared, you will find it lies within the British zone. All of Africa that is habitable, and all of Africa that pays its way, is British Africa." With but very little modification this is correct.

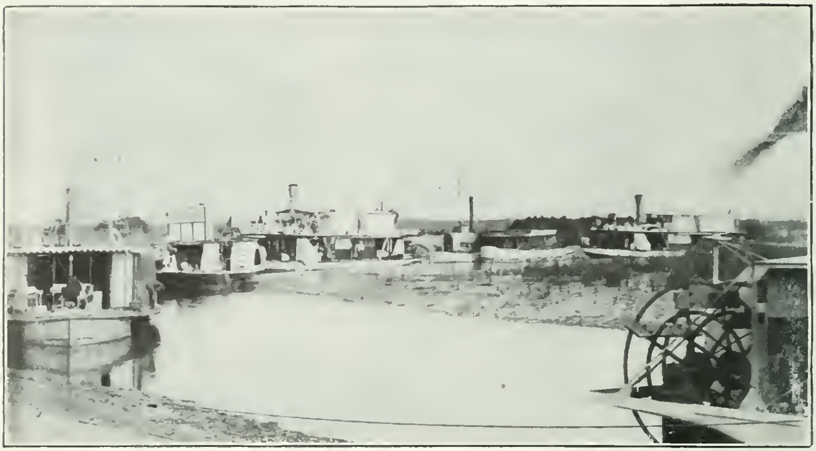
A RIVERSIDE TOWN ON THE CONGO.

Lower Egypt is a garden. Mr. Penfield, lately U. S. Consul General in Egypt, says that its population is 928 per square mile and that it has increased 44½ per cent. since the British control began in 1884. The Soudan, now opening up by the energy of Englishmen, will supply a small population living from the soil, but can never be a manufacturing country, for it has no fuel and probably no important deposits of minerals. There is gold up the Blue Nile which may, perhaps, be worth working on a small scale. A little

AN INLET ON THE WEST COAST OF LAKE NYASSA.

THE WEST COAST OF LAKE NYASSA, BETWEEN NKATA AND DEEP BAY.

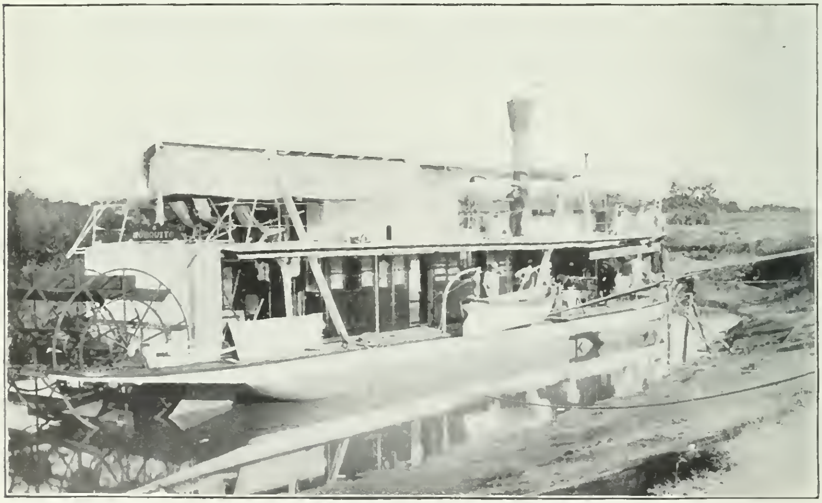
The view shows the mountainous country characterizing this coast, with the many coves and bays. The A. T. T. Company's telegraph line runs along this coast.



GUNBOATS AND STEAMERS IN THE CREEK AT CHINDE.
Chinde is at the northernmost mouth of the Zambezi delta.

trade will again be developed in gum arabic, and in ostrich feathers and ivory coming down from the South, and the people will require some of the products of civilization. But, on the whole, I do not estimate that this country will pay the cost of good government for years to come. It will be a burden on its rulers rather than a source of revenue. This always was Gordon's opinion.

South of the Soudan, all the way from the tenth degree of north latitude to the Zambezi, say to about latitude 17 south, is a country of savages, mostly naked. It is a country of malarial fevers and



H. M. S. MOSQUITO, IN THE ZAMBEZI RIVER.

VICTORIA FALLS, ON THE ZAMBEZI RIVER.

apparently with no coal, iron, gold, or silver worth developing, although it would be foolish to say that valuable gold deposits may not be found. People talk of fine woods and gums and spices. The ebony is sparse in quantity and small in size. I never saw there a stick over six inches through, and seldom so large, and that means about three inches of black wood. It would not be worth shipping out, nor

A BIT OF AFRICAN JUNGLE NEAR VICTORIA FALLS.

can I imagine that any other timber would be found that would bear transportation to the sea in competition with countries that have harbors, navigable streams, railroads, and a climate in which white men can live. It does not seem as if spices or gums could be the basis of a large trade and of a civilization. In 1897, Zanzibar exported cloves to the value of about $450,000, ivory about $640,000 and gums about $330,000. This was the product of a great region which had concentrated at Zanzibar, and probably this trade may be considerably increased with cheaper transportation.

After we get south of the Zambezi, and from there to the Cape, we find a country really important, and at this moment of surpassing interest. Here there are great areas in which white men can live, and smaller areas almost without malarial fevers. There are also great areas in which the fevers are serious. In this country, as we know, lie gold mines, some of them of vast importance. Something like $75,000,000 a year in gold is taken out of the Transvaal mines. It is estimated that this product may be increased to more than $100,-

THE ZAMBEZI RIVER, TWO MILES BELOW THE FALLS.

GOODWIN LEAVING BOPOTO, ON THE CONGO, TO FOUND A MISSION AT YAKUSU.

000,000, with good government.* In the country to the north, now known as Rhodesia, there are mines, the importance of which is still to be demonstrated. Opinions differ widely among those who know the country best, but there can be little doubt that there are gold deposits in Rhodesia which will be well worth working when peace comes again and railroad transportation is developed. The railroad is now built through from the Cape to Bulawayo, 1,360 miles, and Mr. Rhodes will probably carry it on to the Zambezi, while it seems inevitable that a much shorter haul to the sea should soon be established by building a railroad from Beira to Salisbury, say 350 miles.

In all this vast area from the Zambezi to the Cape, covering 18 degrees of latitude, there is necessarily considerable diversity of soil, topography, and climate; but we may say, speaking generally, that much of it is well suited to agriculture, much of it is too arid for agriculture, and a great deal of it is valuable for ranching and grazing. Agriculture, ranching, and grazing will naturally depend a good deal upon the local markets furnished by the mines, and in many regions these are important and will be more so. These industries will also furnish some export trade, and in turn will create import trade. It is not estimated that the country can be valuable for manufacturers. Considerable coal has been developed, but the quality is not good. Labor is of a low grade and dear; there is practically no dependable water power; there are no navigable streams, and timber is very scarce. Considering all these things, and considering the heat, the droughts, and the malarial fevers, which will lower the white man's productive energy in vast regions of the country, we are not justified in thinking that the conquest of the southern part of Africa is to open up anything comparable in value to the world with any like area in North America. We are justified, however, in believing that the moment the war closes and the security and liberty of British rule are established, an important trade will again go on. This trade will be especially important to those who are making engineering products. Mining machinery must be purchased. Railroads must be extended and, as a consequence, bridge material and machinery for railroads and shops must be bought. Naturally, considerable electrical machinery will go into the country, for the most primitive civilization now involves electricity. Within a few months an engineer has

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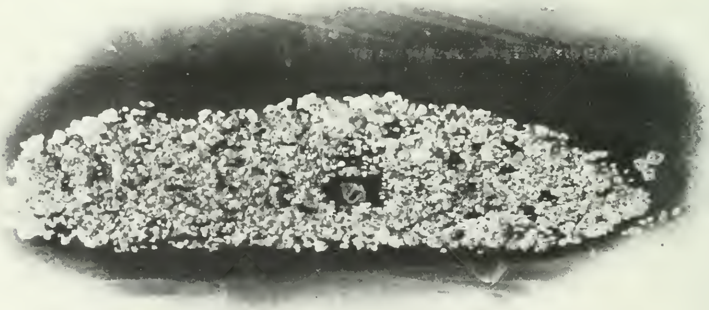
*John Hays Hammond, in his latest official report, which he amplified in the preceding issue of this Magazine, stated that the output would have exceeded £20,000,000 in 1899, had there been no interruption of mining. Dr. Hatch, formerly Mr. Hammond's assistant, writing in THE ENGINEERING MAGAZINE for August, 1899, estimated that within five years the gold production of the Witwatersrand mines would reach the enormous figure of £36,000,000—nearly $180,000,000—per annum. THE EDITORS.

NATIVES ON THE ZAMBEZI RIVER.

visited the United States in the interest of the Chartered Company to look into the art of developing and transmitting power with the aid of electricity. It seems to be believed that some small water powers may be developed in the country and utilized by long-distance transmission.

Concerning all the rest of Africa Mr. Stead is about right. In John Bull's holdings along the Cape-to-Cairo line is included nearly all that is dividend paying. German East Africa, German South Africa, Portuguese Angola, the Congo Free State and the British Niger territories are great savage countries, so fever stricken that no white man who can get a living elsewhere is justified in going there to live, although with some of those countries there is now a valuable trade. A few adventurous men who love to fight, organize, and rule can hold these lands and help the negroes to slow development into producers and consumers, but the process will be tedious and costly in human energy. I remember reading years ago a sentence or two written by David Livingstone, the truth of which was painfully obvious to me at the time. He said, in effect, that for any white man merely to live in Africa was a great achievement—that we must not expect from him very much in the way of moral, or intellectual, or physical energy.

For the illustrations accompanying this article, THE ENGINEERING MAGAZINE is indebted to the courtesy of the British South Africa Company and of Mr. Irwin.



A DAY'S DIAMOND WASH, KIMBERLEY.

CONCERNING THE ACTUAL CONDITION OF THE PANAMA CANAL.

By Charles Paine.

THESE are the facts as they appear to me, after a stay of three weeks on the Isthmus, during which I was able to see substantially the whole line of the canal, from the Island of Naos in the Bay of Panama, where the excavations for a channel begin, through to Christophe Colombe, where the interior harbor has been constructed, connecting with the Atlantic Ocean.

I sailed in a small steamer from Naos up to the mouth of the Rio Grande, where the Panama Rail Road has built a fine modern iron pier 1,000 feet long, roofed and equipped with rapid transporters, and with a connecting basin adjacent to the canal deep enough for the accommodation of such steamships as run to Panama. The channel from Naos to La Boca, as the locality of this pier is called, is 300 feet wide, perfectly straight, and marked at frequent intervals at each side with buoys intended to be lighted at night. The old piers in Panama cannot be approached by any but the smallest craft even at mid-tide, and are high and dry at low tide; hence, it was a clear necessity for the improvement of commerce to provide the La Boca wharf, which is accessible at all stages of water. So the canal may be regarded as nearly completed up to La Boca; above there it has been once completed for a distance of some miles, but has now become considerably obstructed by sediment brought down by the streams which empty into it or into the Rio Grande. The canal appears upon the surface to be of its original dimensions and impresses the visitor just as it will after the deposits shall have been removed. Everywhere, through the portions of the canal which have once been finished, the banks have retained their integrity, and the canal still looks to be in first-rate condition—only the sounding line reveals the sedimentation. I judge that the reason for this is the very rapid growth of vegetation which has covered the banks with a close thicket down to the water's edge.

From Bohio, at kilometre 26 of the survey, but which is 27 kilo-

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The Isthmian Canal, viewed even in its narrowest aspect, is one of the greatest engineering propositions now before the nations. Seen broadly, it is the most important pending addition to the commercial and economic equipment of the world—the largest factor soon to be added to the work of utilising, to the fullest, the earth's material resources. Its influence will be felt in every department of human activity, but foremost of all in the workshop and the factory.

metres from the Atlantic, I passed, upon another small steamer, without obstruction to the pier at Christophe Colombe; yet much of the once completed canal has been silted up and will require to be again excavated; but this is only an expense, not a difficulty, and does not require to be attended to until the more serious parts of the work are near completion.

I had always heard of the Chagres River as the imposing and irremediable difficulty which rendered this route impracticable for a canal, and I now feel much astonished that any engineer should have lent his voice to confirm such an opinion. The Chagres, even in time of flood, is a comparatively small stream; it is crossed by the railroad on a bridge 625 feet long, obstructing the channel with five heavy piers, yet this bridge has stood there about fifty years. Below the railroad there are no tributaries which increase its volume sensibly; it flows through a rather wide valley where there is plenty of room for it and for the canal. Since the resumption of work on the canal several independent channels for the discharge of this river have been provided, parts of the old bed being occupied by the canal. Of course, in its upper portion this river is a mountain torrent, and where it is on the same level as the canal it must be provided for in time of flood, so that it may not overflow into the canal. The present scheme of the Canal Company, to control both the upper and the lower reaches of the river by two dams, seems a good expedient: the upper artificial lake will afford a permanent supply of water for the higher levels of the canal and the lower lake will form an integral part of the navigable canal. It would have been quite as reasonable for opponents of the Erie Canal to have argued that the Mohawk River would render the Erie Canal impracticable as it is now to express a fear of the Chagres as an obstacle to the construction of a canal through the Isthmus.

Indeed, there is only one real difficulty, which will be to raise the necessary funds to be expended where there had been so much waste before. The Culebra cut is perhaps the greatest excavation ever un-

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THE ENGINEERING MAGAZINE values the privilege of giving, at so significant a time, the carefully formed opinions of so high an authority as Mr. Paine, Past President of the American Society of Civil Engineers. The basis of his opinion is his own personal examination, just completed, of the ground and the work accomplished. The weight of his opinion needs no demonstration to an audience familiar with his long and successful direction of large engineering constructions and his intimate association with railway and steamship transportation enterprises. But with a view of putting directly before the eye the magnificent sufficiency of the Panama Canal and of the studies and preparations made for it, THE ENGINEERING MAGAZINE presents, with this issue, a large map of the line, showing to some extent the work accomplished and the minute surveys of every detail in any way affecting the undertaking.

The relations of Mr. Paine's article to previous publications in the Magazine are briefly sketched in an appendix to this paper. THE EDITORS.

dertaken—I believe it to be the biggest; but it has been attacked in the most fearless manner, and, since the resumption of work by the New Canal Company, without any cessation; several thousand men with the necessary excavators, trains, etc., have been and are at work daily upon it. It has seemed to me the most difficult problem here is to find places for depositing this mountainous mass, after it has been excavated, but I am assured there is room enough and to spare.

There are many other good problems for the exercise of engineering ability which would take too long to describe, and I do not wish to minimise the real and quite serious problems of that kind which are presented by the Isthmus; but I declare that "the Chimeras dire" which have been so much talked of, never had any existence, and upon the approach of intelligent exploration they disappeared.

The engineers of the company say that about two-fifths of the work necessary for the completion of the canal at the level adopted for the bottom of the summit level is already done. This level will be 68 feet above tide.

It has been generally known that there was an enormous preparation made for the prosecution of the work by the original Canal Company; yet I had not received even a faint impression of its extent until I came upon the ground. The Isthmus, along the line of the railroad, is covered with dwellings, sidings, contractor's plant, and materials for construction of every description. The dwellings having been built of galvanized corrugated iron have suffered little depreciation; they could house twice as many officials and workmen as are likely to be at any time employed. The scale upon which these things were done is illustrated by the fact that the old company built at Panama, upon the Ancon Mount, a beautiful group of buildings for a hospital at a cost of two millions of dollars, which is very little used, but is maintained in good order by the present Canal Company under the care of Sisters of St. Francis. The company has a branch hospital at Colon, and a sanitarium on the Island of Taboga, which is as large as a summer hotel. All these very little used, but ready. As to the plant, of dredges, barges, dump-cars, excavators, boilers, pumps, track, etc., only an inventory could give an idea; for instance, there are four hundred and twenty contractors' locomotives. All these things are on the ground, and with a little oiling and slight repairs are ready to resume work. There are machine shops fitted up completely, with foundries attached, ready to effect any required repairs, and warehouses containing all the materials necessary for making them. Doubtless many of the dredges will need extensive repairs on their hulls, but there are ship-ways and shops expressly for their accommodation. Out of curiosity I went through twelve of the commissary's long storage buildings at Colon, in which each class of material is neatly piled, numbered, and catalogued, so as to be available upon requisition. Every conceivable material, tool, or piece of apparatus which may be needed for special work or for repairs is in the warehouses; from tacks, screws, files, up to rotary pumps of, say, 20-inches diameter of discharge; even crockery for household use and water closets.

But all these materials and apparatus on the spot, ready for business, will seem of less importance to an engineer than the perfect state of preparedness of the surveys and plans. Every site has been explored, sounded, drilled, and tested; so that the exact character of every cutting, foundation, and superstructure is shown upon elaborate drawings. Practically, there is no more surveying or studying to be done; even if a proposed structure were to be modified, the information required for the engineer's use is ready in the office. These accumulations are the result of the long delay which has occurred in the resumption of work, during which time a large force of engineers has prosecuted the study in detail of every feature of the canal. How great a saving in time and of what enormous value as a guarantee of safety these studies will be, when work is again being driven, engineers who have been hurried before will understand.

The New Canal Company appears to have felt the wisdom of Washington's injunction, "In time of peace prepare for war." The fact is, that splendid engineering talents and eminent scientific abilities have been engaged upon the problems of the Isthmus for a long time, and there can be no more doubt of the substantial sufficiency of their plans and estimates than we should have as to any minor public work which had been examined with care.

There is one more chimera deserving of special attack, and that is the idea that the Isthmus is remarkably unhealthy. The great preparations made by the old Canal Company indicate that it was expected to be so; perhaps the care taken by that company in the drainage of the sites chosen for its buildings and the concentration of the flow into the large streams, have rendered the country more wholesome; certain it is that there is no more sickness among the very considerable population now on the Isthmus than there is among any other equal number in the tropics. The railroad and canal employees now living there are perfectly free from any unusual diseases.

The railroad in operation, and so close to the canal that a siding may be connected with its banks at any desirable point, is a material advantage in the construction of this canal; there are sidings now laid at nearly every station, for the accommodation of the canal plant, which have been disconnected from the railroad tracks, yet only require the replacing of a few rails to be ready for the delivery of supplies. I should guess that the Canal Company must have fifty miles of such tracks, with rails for as many miles more, but this is only a guess. The Canal Company maintains a telegraph line and a telephone wire across the Isthmus, with frequent stations.

I may point out that there are good harbors at each end of the Panama route which are in daily use by several lines of steamships, and also that these harbors are provided with the usual adjuncts, such as wharves, warehouses, coaling and watering facilities, and machine shops, where ordinary repairs can be made. Also that the value to commerce of any ship-canal will be about inversely as the square of its length when compared with that of another. Now, if we are really interested in having a canal between the oceans, here is one much shorter than any other possible line, already half built, if the extent of preparedness is taken into account; why not take hold and build it?

It seems to me that no engineer can cross the Isthmus without being convinced, as I am, that this is a perfectly practicable route and the most desirable one for a canal. CHARLES PAINE.

It may be taken as assured that a very few years will see the completion of a canal across the American Isthmus—the open- of a gateway through the one remaining barrier in the great direct sea-road around the world. To quote Prof. Haupt*: "Probably at no place on the globe would the economy of distance be so great as here, and certainly nowhere else has so assiduous search been made for a passage between the two oceans. * * * The question may well be asked: Why then has it not been completed long ere this?

"The answer must be found in the history of all great undertakings. First, it required some centuries of exploration to find the proper route; second, when discovered, the problem seemed to be beyond the mechanical and financial resources of the times; third, as it was expanded, and adapted to the increasing demands of commerce, additional obstacles and difficulties were presented, of a complicated nature, but having little to do with the physics of the problem."

The situation in this case was indeed complicated by the fact that the first serious effort—an effort which, in the light of the most searching study, has proved to be admirably conceived so far as the physics of the problem are concerned, ended in financial disaster.

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* National Influence and the Isthmian Canal. Lewis M. Haupt. THE ENGINEERING MAGAZINE, July, 1898.

"The new company was definitely formed on October 2, 1894. * * * In 1895, the company employed 3,000 men, and 370,000 cubic metres of material were removed; in 1896, the figures rose to 4,000 men and 700,000 cubic metres; and, in 1897, to 3,600 men and 960,000 cubic metres. Thus the terms upon which the concession was originally granted have been complied with, and work of substantial and permanent value has been carried out.

"In the discharge of this duty they obtained the best engineering advice available, and formed a competent engineering staff. In addition to this, acting under special legislative enactment, they summoned to their aid a number of outside engineering experts,—French, German, Russian, American, and English; all of the men holding or having held, responsible positions, impartial in judgment. and possessed of such experience as to render each man specially fitted to advise on the proposed design and method of construction. In this way the *Comité Technique* was formed.

"Under the direction of the *Comité Technique* the whole of the route of the canal and of its collateral works was accurately surveyed and contoured; borings were made, trial pits sunk, streams large and small, (including the wayward Chagres) gauged, meteorological observations made and recorded, and generally a mass of facts accumulated through which the *Comité* was enabled to agree upon a project for the completion of the Panama canal, with which the new company is prepared to face, to invite, the criticism of the world."*

Such is, in brief, the earlier story of the Panama canal, which Mr. Paine brings down to the very beginning of 1900 in his summary of the conditions as he has just seen them. But meantime another complication of the question has been introduced by the rival attitude assumed by the advocates of the Nicaragua route. However urgent the need of a deep waterway across the Isthmus, the attempted simultaneous construction of two would seem a deplorable waste and probably a fatal disaster to the "least fit," or even to both, of the enterprises. More, it would be a crime against the economy of effort which is the guiding principle of the age. The time is ripe for "the selection of the best possible route and the best possible proposal."

This Magazine has endeavored faithfully to further this purpose by summarising the claims of both routes, and more especially the evidence by which they are supported.

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* The American Isthmus and the Interoceanic Canal. W. Henry Hunter. THE ENGINEERING MAGAZINE, February, 1899.

And at the very outset, a marked difference is to be noted. The history of Panama, with all its faulty past, is the history of actual work accomplished. The construction is approximately one-half finished. The Atlantic channel, 24 kilometres long, and the Pacific channel, nearly 13 kilometres long, have been excavated to full width and need only dredging to restore the full depth. The heaviest work on the great cut is done. The terminal harbors are open to commerce.

But the record of Nicaragua is little more than a record of "concessions." "Since 1893 the financial situation has, in the words of the present president of the Construction Company, 'been bad.' It has been difficult to obtain money, and but little work has been executed. Prior to that date, a length of one thousand feet of pier-work had been constructed at Greytown, a channel had been dredged on the foreshore, and some three-quarters of a mile of the canal had been formed by dredging in the low, swampy ground. A single line of railway had also been formed across the lagoon, from Greytown to the site of the first lock, the length of the line being about eleven and one-half miles. These works, with the addition of certain telegraph lines, represent the sum total of the efforts which have been made to construct a waterway on the Nicaragua line." *

Backwardness of construction might be considered unimportant, if there were strong evidence of the possibility and advantages of the route. But it is with regret that we have repeatedly been forced to deplore the scarcity and unsatisfactory nature of the information concerning the Nicaragua project. "The facts, indeed, are so curiously inaccessible that it is hardly possible to obtain them except in the report prepared by the board of engineers appointed, pursuant to a provision in the act of Congress approved March 2, 1895, for the purpose of ascertaining the feasibility, permanence, and cost of construction and completion of the Nicaragua canal by the route contemplated. * * * It is in the highest degree unfortunate that the edition of the report was so inexplicably limited that hardly a copy can by any means be procured by a private citizen." †

The meagreness of the facts can best be expressed in the words of the board, whose ability and disinterestedness cannot be impugned. The observations of the Nicaragua survey, with respect to rainfall, are "scattering and unsatisfactory"; "the company has omitted attention to the matter and made no careful gaugings at any point"; "the most

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* A Review of the Nicaragua Canal Scheme. W. Henry Hunter. THE ENGINEERING MAGAZINE, March, 1899.

† The Absence of Facts about the Nicaragua Canal. Charles B. Going. THE ENGINEERING MAGAZINE, June. 1896.

serious problems affecting the design and construction of a canal system at the present time are those involved in the heavy rainfall and consequent discharge from the lake and streams," yet "on these points the existing data are seriously defective both in respect of number and continuity"; an important dam is planned near Lock No. 3, but "no borings have been taken at this site and it is not known whether a suitable foundation for a concrete dam can be found"; "the canal company has no detailed plans of the locks and other structures for which its estimates are made, and the board has had to prepare preliminary drawings for the lock estimates." Along the great central-divide cut, 3.15 miles long and 324 feet deep, "new borings * * * are indispensable"; for the east divide cut "the data at hand are so scanty and defective that no satisfactory treatment of the subject is possible." "There are no drawings nor plans for" the guard gates at the San Francisco basins (the series of sixty-seven embankments which are conceded to be the weakest feature of the route) nor is it "clear for what amount of drainage, or for what area, these weirs are intended to provide, as the streams in question have not been gauged in flood nor their watersheds measured." "The company's surveys are mainly devoted to topography, and did not include the collection of hydraulic data." "It appears that the company has made no surveys or examinations of the sixty-nine miles of river between Ochoa and the lake, with the exception of a partial survey by compass which is laid aside as valueless." "The profile furnished by the company is little more than guesswork."

In the time which has elapsed since the Ludlow board made its examination, however, it is to be assumed that the studies have proceeded and that full data have been obtained. The matter, so far as the important factor of the action of the United States is concerned, will doubtless depend wholly upon the report of the eminent commission now examining the question. Every facility will of course be afforded them for the study of both projects. Their conclusion can be awaited with patience and confidence. C. B. G.

The Isthmian Canal, in its most interesting general, political, and economic relations, as well as its engineering aspects, has been treated previously in the following articles published in THE ENGINEERING MAGAZINE:

America's Interest in the Nicaragua Canal. Warner Miller. March, 1893.
The Absence of Facts About the Nicaragua Canal. Charles B. Going. June, 1896.
National Influence and the Isthmian Canal. Lewis M. Haupt. July, 1898.
The Nicaragua Canal in Its Commercial and Military Aspects. Joseph Nimmo, Jr. Aug., 1898.
Equipment, Management and Economic Influence of the Ship Canal. W. Henry Hunter. Dec., 1898, & Jan., 1899.
The American Isthmus and the Interoceanic Canal. W. Henry Hunter. Feb., 1899.
A Review of the Nicaragua Canal Scheme. W. Henry Hunter. Mar., 1899.

ACTUAL EXPERIENCE WITH THE PREMIUM PLAN.

By H. M. Norris.

IN the preceding issue of this Magazine I gave an account of the effort to introduce one of the most modern wage-systems into a shop which, in situation, general character of output, and personnel of its working force might be considered fairly typical of American mechanical establishments.* The importance which the experience might have as an individual case is greatly enlarged by the late developments when the matter came before the International Association of Machinists, for their action defines the gradually crystallizing mind of American union labor. Many writers in this Magazine have based their belief on the triumphant future of the American machine trades upon the American workman's freedom from the industrial heresies and the thralldom to the union which in Europe so strongly oppose the movement toward economy of production. To all who are interested in the adjustment of the problem, this "leading case" is offered for study—I hope for profit—in finding a solution.

My former paper told of the painstaking study of the introduction of the system into the shops, the apparent initial success, the rapid change to dissatisfaction and friction, the seeming covert efforts of some of the men to defeat the plan, and the sudden and serious strain brought on when one of the flagrant offenders was dropped. No strike occurred, though the men's demand for the re-employment of the offender was refused; but an absurd solution was found in not insisting that the men should accept the extra wages earned by them under the premium plan, and freely offered by the company. The plan was, to this extent, withdrawn, and a final earnest effort to induce the men to accept it on trial for a year was suspended pending a promised consideration of the whole matter of the premium system by the convention of the International Association of Machinists, which was then near at hand. Mr. McConnell, the grand master of the association, promised to refer the general question and my particular propositions to the convention in his biennial report, and there the matter rested at the stage described in my former article.

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* The works of The Bickford Drill & Tool Co., of which Mr. Norris is engineer and works manager.

This review began in THE ENGINEERING MAGAZINE for January, 1900. Preceding papers of closely related interest are:

Methods of Remunerating Labor. P. J. Darlington. June, 1899.

Systems for the Remuneration of Labor. P. J. Darlington. Sept., 1899.

Three weeks after the opening of the convention I wrote again to Mr. O'Connell, saying that it had been reported that the premium plan had been strongly denounced, and asking for an early submission of the promised report. The reply stated that the report of the proceedings would very soon be ready for distribution, and was accompanied by a copy of the grand master's biennial report. My acknowledgment of this letter read as follows:

> "Dear Sir: I have your valued favor of the 24th, together with copy of report of the grand master machinist, for both of which I beg to thank you.
>
> "I have not yet had an opportunity of examining the latter in detail, having read only that portion which relates to piece work, but it does not seem to contain the information I am seeking, namely, the decision of the Association in regard to the use of the premium plan. Possibly the proceedings contain this knowledge, but in case they do not, will you be kind enough to advise me by letter, in order that I may know what to expect from our men in case we should think best to ask them to agree to give the system a year's trial."

To this letter I received no answer, but in course of time came a copy of the proceedings, from which I make the following extracts, quoting first from the grand master's report:

> "One of the most important matters to be considered by the delegates of this convention is the question of piece work, and other plans of paying for work performed by machinists.
>
> "There is no denying the fact that piece work and the premium plans are constantly growing in our trade. Although we have succeeded in many instances in preventing the introduction of piece work, yet the volume of the same is increasing. It is useless for us to any longer hide our heads under a bushel, refusing to squarely face the matter. There is no one who believes more firmly than I do that piece work is detrimental to our trade; it not only works injury to the tradesman, but results disastrously to the employer. We might as well follow the example of that famous bird, the ostrich, that buries its head in the sand, believing that if it cannot see, it cannot be seen. as to continue our present method of fighting piece work.
>
> "First, because we allow our members in some shops to work under the system; although the same firm may own the shop across the street, our members cannot accept the system there under our constitution. When we go to employers with this state of affairs existing, we are placed in a most ridiculous position.
>
> "During the past two years we have spent more money and devoted more time of the officers to the question of piece work than to any other portion of our trade. In many instances our efforts failed. As a result, many lodges were lost to the association. I call your attention to the conditions prevailing on the Chicago, Burlington and Quincy Railroad, where we lost

four lodges because of the introduction of piece work. We did all in our power to assist our lodges located on the road to resist the introduction of piece work, but there being a number of our members who were desirous of accepting the plan, made it impossible for us to do anything. In fact, letters were received at headquarters from our lodges on the system, insisting that the grand lodge keep its hands off the affair.

"Lodges have been lost in other sections of the country, not because the grand lodge made no effort to prevent the introduction of the system, but in many instances because, when the grand lodge tried to prevent it, those who were desirous of accepting piece work succeeded in disrupting our lodges.

"A new plan is now being tried in some localities which in the main does away with the old practice of piece work and introduces what is known as the premium plan of paying for work performed. This guarantees to the men that they will receive their regular wages whether the same is made by them or not.

"Mr. F. A. Halsey, associate editor of the *American Machinist,* in the March 9th issue of that paper, gives a plan which is being rapidly taken up by the manufacturers. The Bickford Drill & Tool Company, of Cincinnati, too, made an effort to introduce the system. But members would not accept it. I was called to that city and had an interview with Mr. H. M. Norris, the superintendent of the company. I explained to him that nothing could be done in this matter until after our convention, but if he would agree to let the question stand as it was for the present I would submit his plan to the convention for consideration. This he agreed to. I herewith attach his proposition:"

Mr. O'Connell gives my proposition * in full, after which he says:

"The delegates to this convention will fully appreciate that some definite action must be taken as our position in the future regarding the introduction of piece work and premium plans. In my opinion it would be wisest policy for us to face the inevitable, select the best system, then control it. I am satisfied if this is done we can rapidly unionize a large number of manufactories which we are now constantly fighting."

During the afternoon session of the fifth day of the convention the chairman stated that the grand master machinist had requested the committee on law to present a plan for piece work. Their deliberations resulted as follows:

"Recognizing the great inroads that the premium plans and the two or more machine systems are working into the machine shop of the present day, we believe it is essentially necessary that legislation of a definite nature should be enacted whereby the International Association of Machinists can successfully manage and control them. We realize that to further combat the system of premium plans will be suicidal on our part when we consider the fact of the many members of our organization being engaged in them at the present time.

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*See THE ENGINEERING MAGAZINE, January, 1900, pp. 583-584. The eight sections of Mr. Norris' proposition are embodied in the report of the committee on law, page 692, this issue.

"Your committee on law realize that this is a knotty problem to solve in presenting a plan whereby we can successfully deal with this question on the start. We do believe, however, that the plan herewith submitted will, in a measure, serve as a guide wherever the system is in operation, or may be introduced in the future. We might also add that practical experience is the greatest teacher in all things, and during the next two years we will get the benefit of it, at which time will be better able to amend or improve the plan herewith submitted.

"Members of the International Association of Machinists can accept premium work under the following conditions.

"1st. That each employee shall be guaranteed his regular day's-work wages.

"2nd. That the time limits shall never be lower than the average time made with the same tools under the day's-work plan.

"3rd. That no one shall be discharged because of failure to reduce his time below the limits.

"4th. That in addition to his regular wages each employee shall be paid one-half of his regular hourly rate, for each and every hour he may reduce his time below the prescribed limits.

"5th. That the limit, once fixed, shall not be lowered except through the introduction of new methods of doing the work.

"6th. That all the premiums shall be paid within two weeks of completion of the work upon which they were earned.

"7th. That at the end of one year's time the plan will be withdrawn from all those not wishing to continue working under it.

"8th. That if withdrawn the employee shall not be required to work at the same rate without an equivalent in wages.*

"9th. Any member of the I. A. of M. working at the premium work system shall not be permitted to earn more than 10 per cent. in excess of the average wage paid in that locality. Shop committee shall ascertain each pay day the amount earned by each member under the premium work system. All over 10 per cent. he may earn shall be forfeited to the lodge of which he is a member, and report same to the financial secretary of the lodge.

"10th. No member of the I. A. of M. shall be permitted to run two or more machines except where an agreement has been entered into with organization and the firm. Such agreement shall only apply to special machines and shall require all machinists to be members of the I. A. of M."

During the discussion which followed the reading of this report, one of the members remarked that no union man could entertain the idea of piece work or of running two machines. Another said: "Piece work has come to stay. We must either abolish it or control it. The only way to abolish it is by the coöperative commonwealth, but we are not ready for that yet. In a shop in New York the men work piece work or premium plan, and all they receive above $18 per week is devoted to a defense fund. The last clause of the plan, as submitted by the committee, provides for an agreement on the part of the organization and the firm. We can get agreements with nine-tenths of the firms in this country, and I move that we adopt last clause of committee's amendment and insert 'or accept piece work' after 'two or more machines.'"

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* Conditions 1-8 are identical with the proposals framed by Mr. Norris for the introduction of the premium plan into the Bickford shops.

The remarks of some of the speakers were indicative of the general temper. One said that "in his section they had tried to introduce piece work. Man after man had quit work because of it. Now they had got it where the master mechanic said: 'we are going to give up piece work; it is causing us too much trouble.'" Another "thought it was a hard nut to crack, but the piece work could be abolished. They had done it in one shop. When the manager was first approached about it he only laughed, but they had dinged at him and donged at him, until he had abolished it." Still another told how "they had driven out piece work by a man taking four weeks to do a job which he could have done in two." To the argument that "the plan submitted by the committee gives a year in which to try the agreement, at the end of that time it could be withdrawn," an opponent responded that "if we contracted a disease for a year, we could not then get rid of it. It was so with piece work; if we worked it for a year, we could not then drop it. He had come to the convention pledged to vote against it." The next speaker said "piece work was here and bound to stay, so let us settle the question to-day, or two years hence we would not have ten delegates to the convention."

The grand master's report on piece work was then read, after which Mr. O'Connell addressed the convention, saying that "after great study he felt that it was his duty to bring this matter up, as the manufacturers of the country are making strenuous efforts to introduce the piece-work system. He then explained the difference between the piece-work system and what is known as the premium plan. He reported several interviews with firms, and advised the convention to adopt some law that would allow the officers of the I. A. of M. to cope with this evil. Said he hoped some means would be devised to regulate this system, as we had lost nearly all our lodges on the C., B. & Q. from it."

It was then moved and carried "that a committee of five be appointed to draft a plan to govern this system." This committee reported as follows:

> "Your committee beg leave to report that, after due deliberation, we have become convinced that, under the present conditions existing in some parts of our country, we are forced to provide some legislation that will compromise, in a manner, between those who ask for protection where piece

> work exists, and those who appeal to us for a law which will prevent its introduction; and we further realized the fruitless attempt to drive the monster from among us, at the Kansas City convention, when Section 3, Article XXII., in our convention became a law, and which from its date has been a dead letter. We therefore annul Section 3, Article XXII., by striking all out and substituting the following:
>
> "That our judicial officers be given discretionary power to treat with employers where piece work now exists with I. A. of M. members, and to make agreements as prescribed by the premium system, and thereby control and eventually abolish piece work in any form."

The remarks of individual speakers again furnish an index to the attitude of organized American labor to the newer wage systems: "There is no provision in this report to prevent a man from doing piece work. No fine is placed on him. If you want to stamp it out, make it cost a man so much that he will not want to do it." * * * "The plan submitted will control it as much as it ever has been controlled. This prevents piece work from spreading where it does not exist. The way to put that law into operation is to give the executive officers power to make contracts where piece work now exists." * * * "It gives the executive officers a chance to prevent piece work from going any further. It cannot come into places where it has been stamped out." * * * "Put it in the hands of the executive officers to accept where it cannot be helped, and stamp it out where possible." * * * "The premium plan is just as bad as piecework. In my city the premium plan was introduced in a shop. The men earned $16, $18 and $24 a week. They did not know where to stop. The company had to cut them down. I do not wish to see the premium plan endorsed one iota." * * * "We do not want piece work in any form, but we must provide for it where it exists. It was not right to have a law that was violated, as the past law has been. To substitute the premium plan where piece work now exists was a compromise between those who did want piece work and those who did not." * * * "We are not in a condition to-day to antagonize the shops that are already working piece work." * * * "I work in a piecework shop. The men agree among themselves how much they will earn; but I am opposed to the plan in principle."

On call of the question, the report of the committee was adopted.

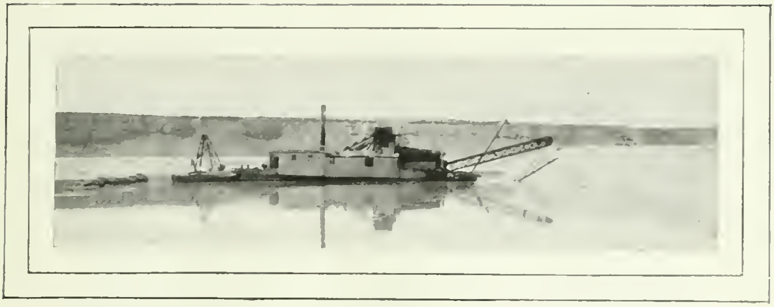
It is to be regretted that Mr. O'Connell's explanation of the difference between the piece work and premium systems is not recorded on the proceedings, since we have no other means of judging the comprehensiveness with which it was made. Biassed himself, according to his own declaration, it is safe to assume he said little to influence a biassed audience. It is encouraging to note, however, that there are in the union at least a few men who realize the fruitlessness of combating the inevitable. Piece work in one form or another is here to stay. It can never be driven out. The union can forbid its members working for less than a stipulated amount per day; it can say that their earnings shall not exceed a certain figure per week; it can even insist that they all work at exactly the same rate per hour, but piece work will continue forever, the term meaning certain pay for certain out-put; and if manufacturers are prevented from grading its employees according to their individual merit, it means simply that all workmen will be obliged to maintain a certain out-put in order to hold their jobs at all, the rate of pay and amount of out-put still continuing hand in hand.

In the words of the memorable Lincoln: "You can fool some of the people all the time, and all of the people some of the time, but you cannot fool all the people all the time." The American workman is no dummy. He will not long be deceived by the *ignis fatuus* of the union. There is sure to come an awakening sooner or later, and when he realizes that the organization to which he was led to look for a betterment of his condition is passing resolutions forbidding him "to earn more than 10 per cent. in excess of the average wages paid in that locality," it is little wonder that there should be disruptions in the ranks, and many losses of lodges to the union. Can one imagine a more inane proposition than that contained in the 9th paragraph of the law committee's report, which, if the average rate of wages is 22 cents per hour, prohibits a 26-cents-per-hour man from earning more than $16.92 per week, an increase of but .022 cent per hour? This, it will be seen, offers a greater incentive to the poor workman than to the good. If average wages are 25 cents per hour, the 20-cent man is permitted to earn an increase of 12½ per cent. of his wages, while the 30-cent man is restricted to an increase of but 8 1/3 per cent. of his wages. Affairs have indeed reached a lamentable state when the workman himself puts forth the obstacle to a betterment of his condition, and sets at naught all efforts in his behalf.

The situation becomes more critical every day. Intelligence from New York City announces the federation of 500,000 workmen, begun at this writing, hoping thereby to end the career of strikes, in supplanting present methods by arbitration. The purpose is a good one, and deserves our enconiums, could we credit it. We are, however, led to ask, can this promise carry much weight in view of the fact that labor organizations recognize and favor such deceptions as are practiced by some of their members and reported in open convention without a dissenting voice? Take, for example, the statement of the speaker who acknowledges driving out piece work by taking four weeks to do a job which he could have done in two.

It is asserted that the spirit of labor organizations is the eternal brotherhood of man; that this is the corner stone upon which it so successfully builds; that in this sentiment lies the strength and hereupon rests the glory of the institution; all of which is beautiful and would redound to the credit of labor were it true. Is it not true instead that organized labor is assuming the bigoted position of the churches of old, claiming that no good exists outside of its fold, salvation being possible only in its ranks? Is it the spirit of eternal brotherhood that demands the discharge of a co-laborer, an excellent workman, a man of sturdy habits, admirable probity, born to earn his livelihood like his organized brother, by the sweat of his brow, for no other reason than that, to his understanding, membership in a union could add nothing to his force as a workman, since it desires not selected labor, but any labor? Is this the spirit of eternal brotherhood or is it the spirit of intolerant bigotry? Is it not relentless fanaticism as well as arrant knavery which admits, as was admitted in recent convention, that the men employed in a piece-work shop agreed among themselves how much they would earn, thereby frustrating the plans of the employer? What an astonishing distinction is made as to who gores the ox, for should the employer have limited the wage earning capacity of these same men it would doubtless have resulted in a strike. Again, is it brotherly love, or is it the very essence of sublime selfishness which dictates that the earnings of a capable man, of excellent character and steady habits, on whom a large family may depend for support, shall be no greater than that of a man perhaps having no one dependent on him and whose work and habits may be far from exemplary?

In view of all the anarchy practiced, the demands made, the want of recognition of humane methods employed, there may be forced into the ring a new factor, namely: an organization of employers, a union founded for the purpose of self-protection, demanding, only, what is right and fair. Should the number of segregated, isolated, employers in sympathy with each other ever become a concentrated, vigorous, organized force, labor would be confronted by a panoplied wall that all its combined efforts would find it futile to attempt to overthrow.



The Gold Dredge Chicago. Esquilant, Photo., Dunedin.

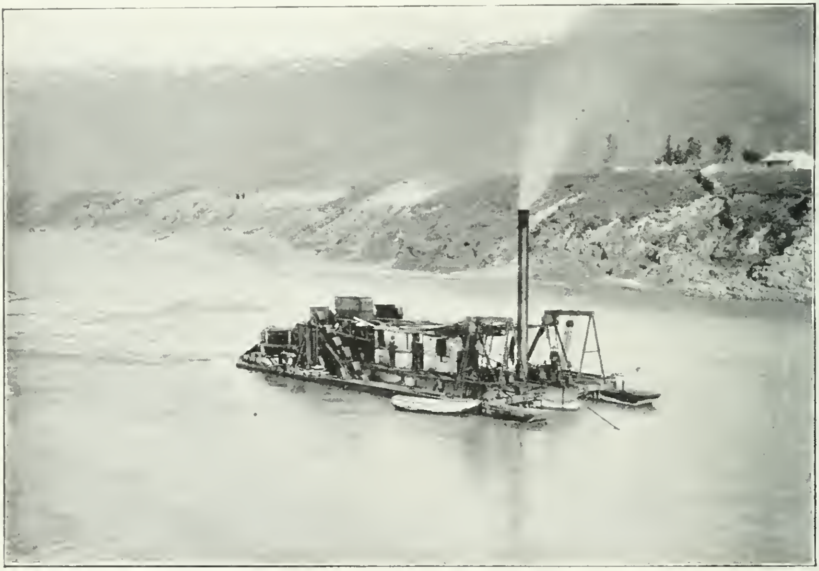
THE ORIGIN AND PROGRESS OF GOLD DREDGING IN NEW ZEALAND.

By W. H. Cutten.

THE success of dredging as a branch of the gold-mining industry in New Zealand is now so firmly established and so widely recognised as to call for little comment. In the space of the last thirty years, gold dredging has advanced by leaps and bounds, as each fresh improvement upon the early crude attempts has been added with satisfactory and stimulating results. It is now about thirty-four years, as far as can be ascertained, since the first attempt to dredge the River Molyneux was made. The machine then employed consisted merely of a strong iron ring, technically known as a spoon, to which was secured an ox-hide bag and a long pole. A rope was fastened to the aforesaid iron ring and secured to a hand winch on the bank of the river. The bucket and pole were taken out and dropped into the stream by means of a boat, the bucket being pressed by the pole as deep as possible into the wash in the bed of the river. All that remained to be done was to haul the bucket ashore with the help of the winch, the contents being then cradled in an ordinary miner's cradle.

The next step in advance was the use of a wooden pontoon, moored out in the river, upon which a hand winch was fixed at one end to work the spoon. The spoon was dropped into the river at one end of the pontoon and dragged to the other end by means of a rope attached to the winch, while one man kept the spoon pressed down into the wash; a greater quantity of wash was thus secured with less waste of time. These little spoon dredges answered very well and obtained good returns, in some instances as much as 70 to 80 ozs. of gold per week, until sluicing operations, starting along the banks, made it impossible for the small craft to cope with the amount of drift being sluiced into the river, and one by one they were laid aside as useless.

After a brief interval, a steam spoon dredge was designed with which to overcome the drift difficulty. This was about the year 1870, and affords the earliest record we have of a steam dredge on a New Zealand river. The dredge roughly resembled the present style of machine, being formed of two pontoons held apart by beams bolted to the decks, thus leaving a well some 3 feet wide between; through this a spoon, larger than any hitherto used, was worked by means of a steam winch. For about two years this dredge apparently paid well, but eventually she also proved useless on account of the continued increase of drift, and so had to be laid up.

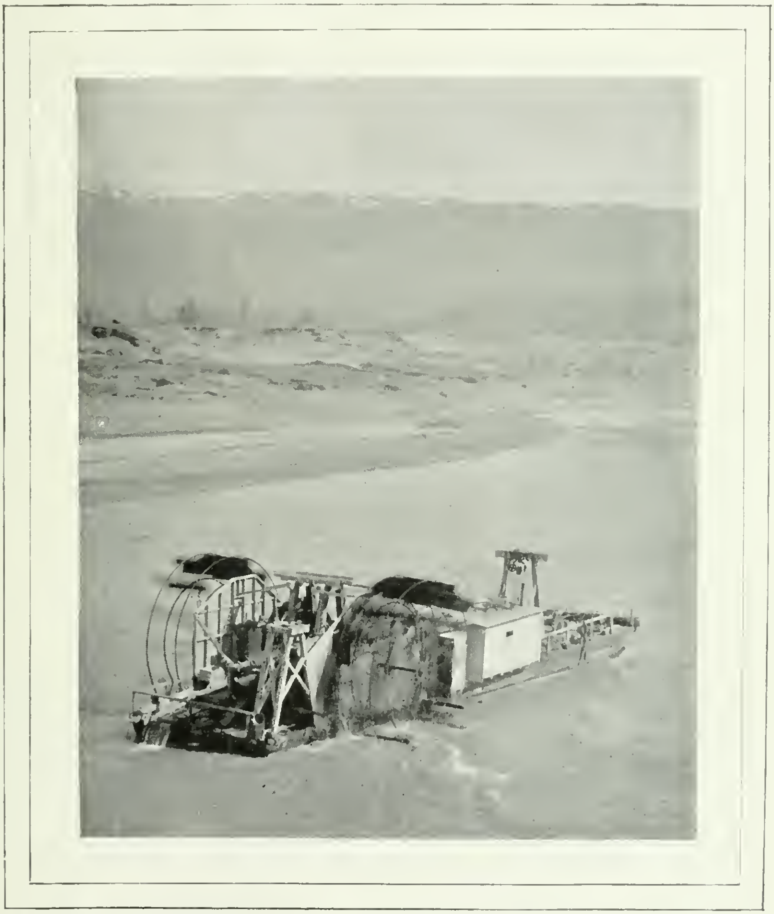


McEachen, Photo., Alexandra.

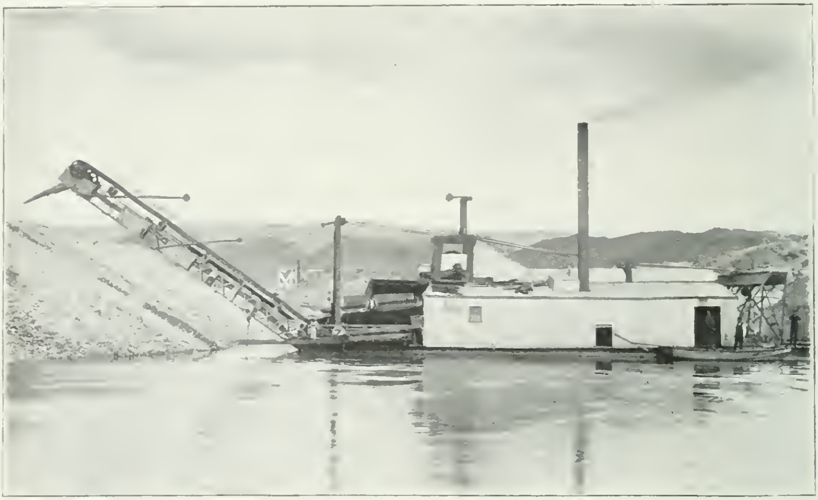
DUNEDIN DREDGE. THE PIONEER OF THE STEAM BUCKET TYPE.

The spoon dredge was superseded by the bucket-and-ladder dredge, which was first driven by the current of the river, acting on a large pair of side wheels with floats resembling the paddle wheels of a steamer. These dredges worked well so long as the gold was confined to the river beds, but were quite unable to follow the leads of gold which were found to run into the banks. Some of them have since been fitted with steam power, and have paid remarkably well.

Up to 1894, dredging operations were confined almost entirely to working the beds and low beaches of the rivers or flats. The high banks were unworkable on account of inability to stack tailings clear of the stern of the dredge. This difficulty for a time threatened seriously to cripple and to limit dredging operations, and it seemed as though much valuable ground would have to remain untouched. However, while working the Enterprise dredge in 1894 the author was confronted with this difficulty, and to overcome it designed and constructed what is now termed a tailings elevator. This machine consisted of a ladder, fixed to the stern of the pontoons and projecting at an angle of about 35 degrees to water level. A continuous chain of flat iron trays encircled the ladder and ran over two iron tumblers, one


Esquilant, Photo., Dunedin.

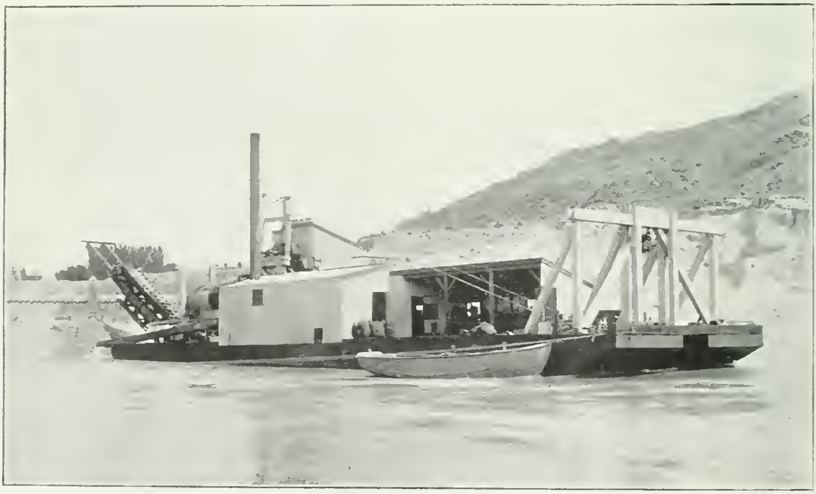
THE PERSEVERANCE. A CURRENT-WHEEL DREDGE.



McEachen, Photo., Alexandra.

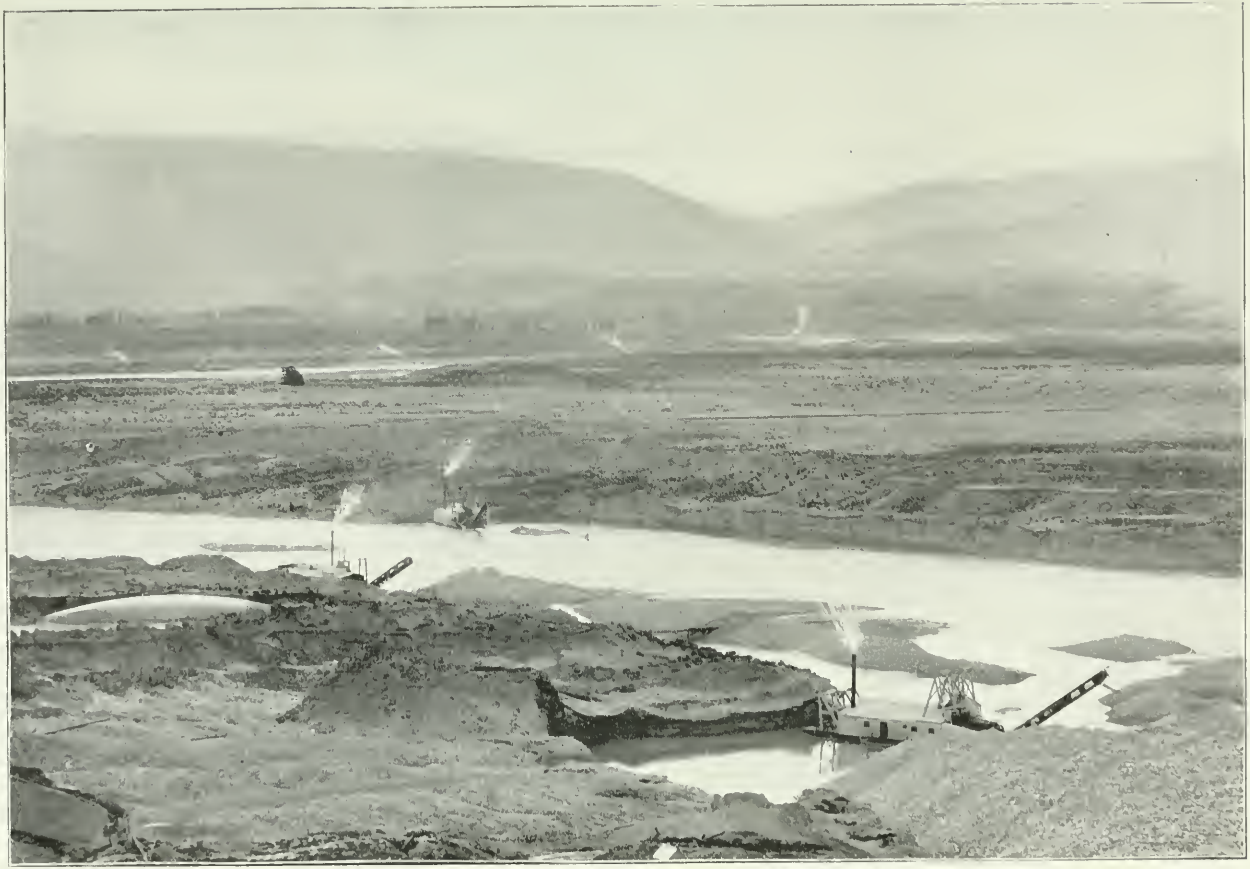
THE EUREKA NO. 2.

at the top and the other at the bottom of the ladder. By this means the rough portion of the wash dirt, after passing through a revolving screen and being sluiced in transit, was delivered over the elevator and dropped at some distance from the stern. In consequence of this invention high-bank claims became workable and several dredges are today eating their way into faces fully 40 feet above the water.



McEachen, Photo, Alexandra.

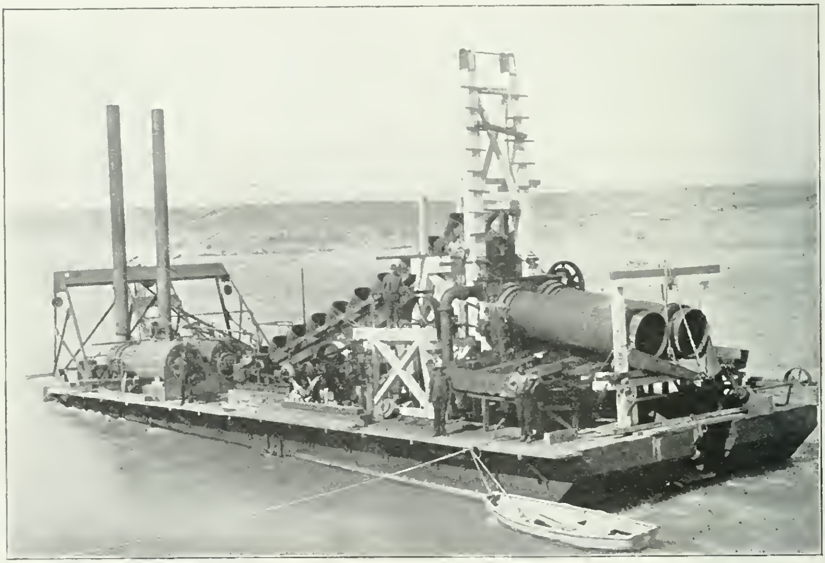
A LARGE MODERN DREDGE—THE VINCENT.



McEachen, Photo., Alexandra.

VIEW OF EARNSCLEUGH FLAT AND MOLYNEUX RIVER, SHOWING TEN DREDGES AT WORK IN THE RIVER AND ON THE HIGH BANKS.

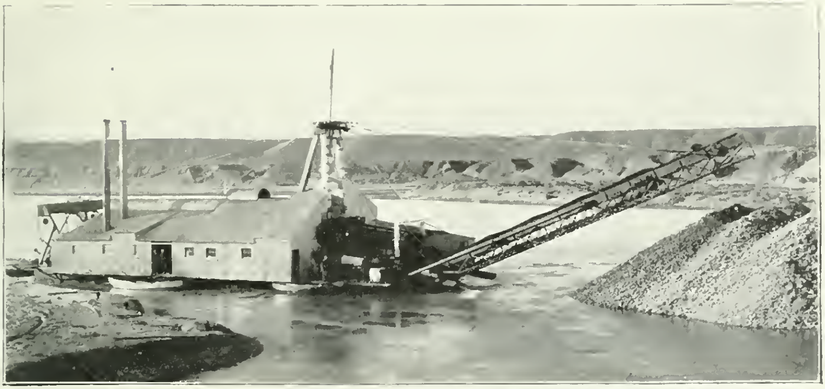
Having briefly outlined its early history, we will turn to the up-to-date aspect of the dredging industry and give a short description of the gold-dredging machine of 1899, selecting for the purpose of example the Earnscleugh No. 2. This is the largest gold dredge yet constructed in New Zealand. She was designed for a private company consisting of five men. The pontoons of this dredge are of New Zealand kauri, with framing of Tasmanian hard-wood, the length being 98 ft. and breadth 30 ft.; they are 7 ft. 6 in. deep aft, tapering to 6 ft. 6 in. forward. The ladder well is 5 ft. in width. There is also a short well aft, 5 ft. 6 in. wide, to accommodate the tailings elevator. The bucket ladder is of steel, 70 ft. long, and is capable of dredging to a depth of 38 ft. below water level. The gearing is of cast iron, heavily made and shrouded, and turned to the pitch line of the teeth.



McEachen, Photo., Alexandra.

THE EARNSCLEUGH NO. 2, THE LARGEST GOLD DREDGE IN NEW ZEALAND, IN COURSE OF CONSTRUCTION.

On the gearing between the engines and the buckets is a neatly arranged friction clutch, which allows the buckets to stop when they come in contact with anything too hard or too heavy to lift, and to start again when the pressure is removed. By merely moving a lever the winch-man can at any time start or stop the buckets, without in any way interfering with the running of the engine and other machinery. The winch, which is driven by a separate engine, is fitted with seven barrels or drums, any one of which can be worked independ-

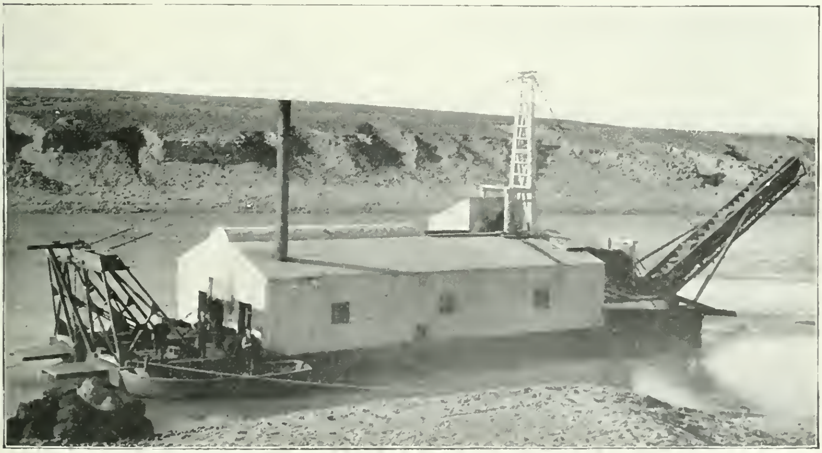


McEachen, Photo. Alexandra.

THE EARNSCLEUGH NO. 2, COMPLETED AND HOUSED IN.

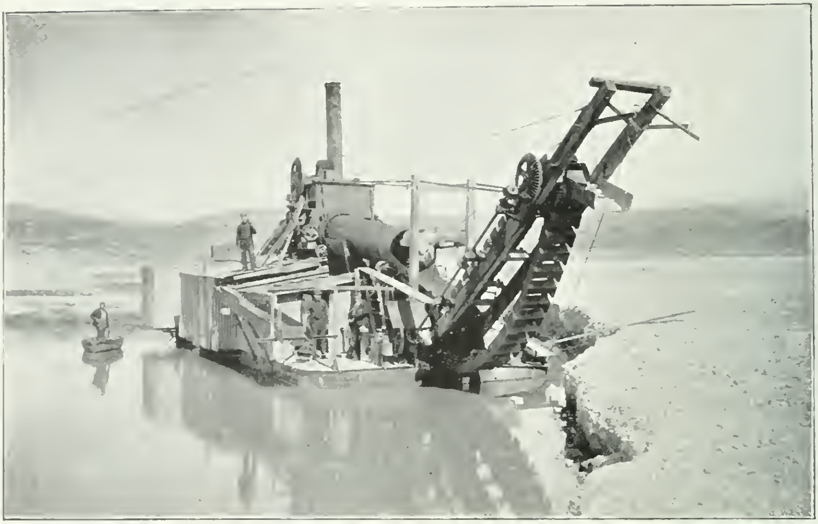
ently, or the whole seven in unison, by the moving of levers. Four of the barrels are connected with the quarter lines which move the dredge from side to side in working a cut. The fifth barrel is used for raising and lowering the ladder, while the sixth is for the head line which holds the dredge up to its work. The remaining barrel is a spare one and is used occasionally for lifting heavy weights, or for a second head line in case of floods. These lines are flexible steel wires. The winches occupy a space 18 ft. by 6 ft., and the man in charge does not require to move more than 15 ft. to work the whole seven barrels.

There is a continuous chain of thirty-six steel buckets which work



McEachen, Photo., Alexandra.

MATAU DREDGE, ALEXANDRA. A TYPICAL MODERN DREDGE.

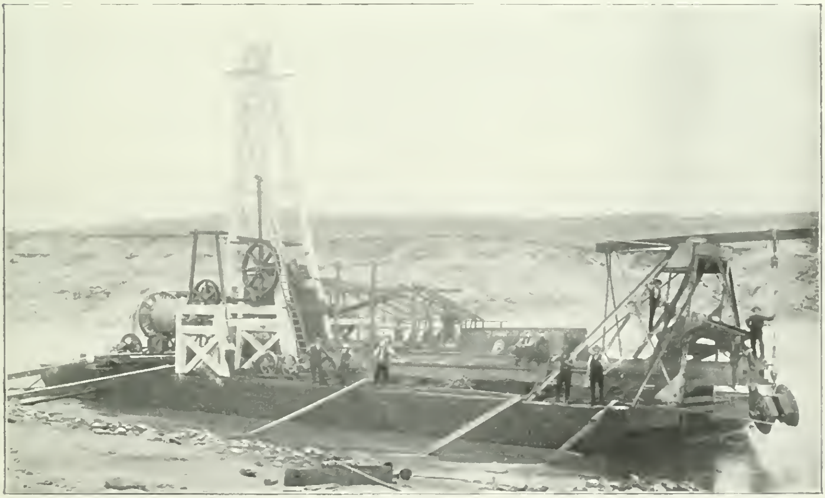


Esquilant, Photo., Dunedin.

ENTERPRISE DREDGE. THE FIRST IN NEW ZEALAND TO BE FITTED WITH A TAILINGS ELEVATOR.

The dredge is working into a low bank on the Clutha river.

over top and bottom tumblers of cast steel and are carried up the ladder on rollers 18 in. in diameter. Each bucket has a capacity of 6½ cu. ft. This dredge is capable of lifting and treating 19,800 cu. yds. of gravel per week. Her engines are surface condensing of 20 h. p. nominal. They are connected with the machinery by a 15-in. belt which absorbs all shocks occasioned by dredging rough and rocky ground. Another belt from the fly-wheel transmits power to a 12-in. centrifugal pump, which supplies water for washing the dirt. This pump answers a double purpose, as it draws the water through the condenser of the engine and assists in keeping it at a normal temperature, and prevents the tables from freezing in cold weather. There are two boilers, each of 16 h. p. nominal, carrying 140 ℔s. pressure. These were specially designed for the use of dirty water and are what may be called loco-tubular with circular furnaces. The furnace end is larger in diameter than the other, in order to reduce weight of boiler and contained water, and to allow for the unequal expansion which is experienced in boilers of the Cornish type when fired straight through without returning the flue on the bottom. Both engines and boilers were imported from England. The elevator consists of a ladder, in the form of a box open at the top and latticed at the sides to form a girder. It is fixed to the stern of the dredge by a pivoting shaft, and is supported by four steel-wire ropes leading to masts 40 ft. high set in the center of the dredge. It is stayed at the sides by two steel pipes about 9 in. in diameter, and by two steel-wire ropes. At each end of the elevator there is a pair of light seven-sided tumblers over which the buckets revolve, and inside the upper portion of the ladder are fixed six pairs of rollers on which the buckets travel; there are a corresponding number of rollers on the lower part to support the returning empty buckets. The elevator is driven from the lower tumbler by means of a gearing connected with the main gearing by a belt. All the machinery, excepting the centrifugal pump, air pump, and condenser, is above deck and easily accessible for repairs. After the dirt has been lifted by the buckets, it is discharged into a double shoot made of steel, and thence it falls into two revolving steel cylinders or screens, each 16 ft. 6 in. long, 4 ft. in diameter, and perforated for 12 ft. of their length with holes ranging from 5-16 in. at the upper end to 1-2 in. at the lower. These screens have a fall towards the stern of the dredge, and each contains a perforated water pipe. As the dirt passes slowly through the screens it is subjected to a continuous shower of water from these pipes, and the smaller portion of the dirt, with the gold, is thus washed through the screen holes onto the tables below, while the rough wash and stones pass out into the elevator buckets. The tables for saving the gold are covered with lengths of cocoanut matting, and under these calico is laid to save any fine gold which might otherwise escape through the matting. The matting is kept in its place



McEachen, Photo., Alexandra.

THE NEW ALEXANDRA DREDGE.

by wooden battens wedged to the side divisions of the boxes. Wire netting is largely used on dredges to cover the mats, as it forms ripples which aid in saving the gold, and protects the mats from wear.

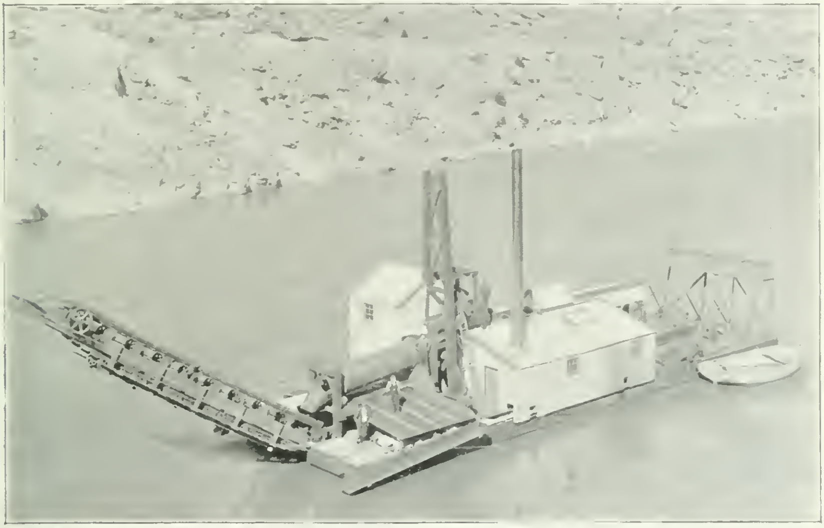
The working expenses of the Earnscleugh No. 2 can be set down at about £60 a week. This includes wages, fuel, wear-and-tear, oil, waste, etc., thus making the cost of lifting and treating a cubic yard of gravel a little less than one penny. This is allowing for 25 per cent. of loss for buckets coming up only partially full. The capital cost of the Earnscleugh No. 2, in working order upon its claim, was £9,500.

The process of "washing up" and "streaming down"—or, in other words, the releasing of the gold from the mats, requires a few words of explanation. The mats, both calico and cocoanut fibre, when lifted are carefully washed in a large wooden box or trough about 2½ ft. in depth by 4 ft. long and 3 ft. wide. A miniature tail race, consisting of an inclined flat wooden tray about 12 ft. long, is then erected. At the upper end is placed a box some 20 in. square, fitted with a perforated iron tray and having the bottom open; both box and tail race are covered with small mats of green baize or plush to catch the gold. The dirt is then scooped with a long-handled shovel from the large trough, and is placed upon the perforated top of the box, and washed by means of a hose. After all the wash dirt has been passed through the streaming-down box, the plush or baize mats are lifted and washed in an iron bath; the coarser gold is then separated from the finer by means of wide gauze sieves, and the return is then dried, cleaned, and finally weighed and sealed up. The whole operation takes four or five hours to complete, according to the quantity of gold.

At the present time the dredge which heads the list in the way of good returns is the famous Hartley & Riley. She was built by a firm of Dunedin engineers at a cost of about £5,800, from designs by the author's firm. Although not very successful at the start, it was not long before she got onto extremely rich ground, and from thenceforth her returns have been phenomenal. For the last fifteen weeks she has won from the river 7,950 ozs. of gold, giving an average of 530 ozs. a week. The Hartley & Riley holds the record return for any gold dredge working in New Zealand, viz., 786 ozs. of gold for six days' work, the previous record being that of the Electric Company's dredge —658 ozs. Of course, the Hartley & Riley is an exceptionally rich claim, and though, no doubt, many of the machines now in course of construction, and some of those already at work, may give very good accounts of themselves in the future, it is hardly probable that we shall hear of many larger returns than those above quoted. This, however, is a matter of conjecture. Improvements may possibly be made upon the present method of lifting and saving gold from rough and rocky claims. But as a matter of fact, in spite of various attempted improvements, there have been no appreciable alterations during the last nine years in the process of treating and saving the gold won by dredges.

An ordinary sized machine costing, say, £3,000 to £4,000, if it can be relied upon to secure even 20 ozs. a week, gives very good returns.

There are about one hundred dredges working in New Zealand, 90 per cent. of which are in Otago and the balance on the West Coast. Seventy-six of the total are owned by public companies and the remainder are the property of private syndicates and individuals. To show the faith evinced by New Zealanders in the future of the industry it may be mentioned that, since the beginning of this year, considerably more than one hundred companies have been floated with an aggregate capital of £1,250,000.



McEachen, Photo., Alexandra

THE HARTLEY AND RILEY DREDGE—THE "KING OF GOLD DREDGERS."

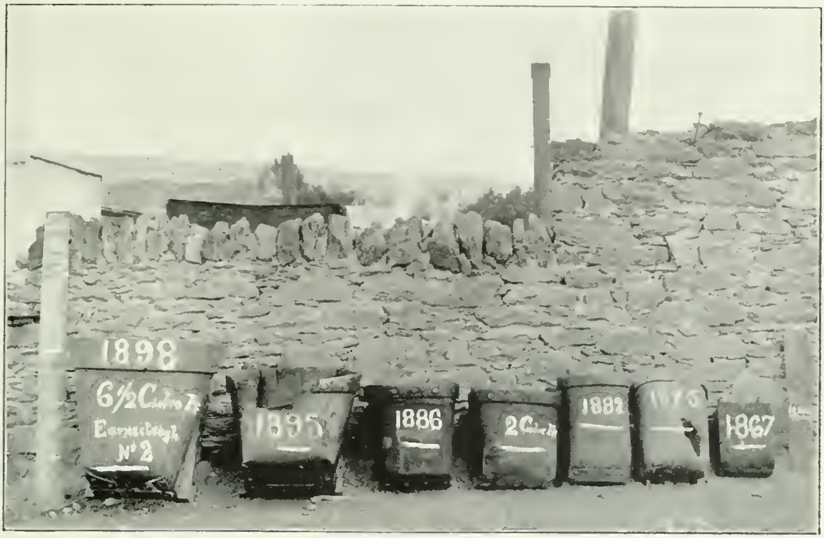
The returns from this dredge averaged 530 ozs. of gold per week for fifteen consecutive weeks, the record week being 786 ozs. It repaid its entire capital cost out of less than three consecutive weeks' returns.

Up to the present operations in New Zealand have been chiefly confined to Otago, but recently attention has been turned to the West Coast, where many claims have been pegged off and dredges are in course of construction for them. Some of these claims are very rich, but rough, and consequently will require very powerful machines.

So far this article has dealt only with dredging as it is carried on in river claims. There is, however, another branch of the industry which is attracting a great deal of attention, viz., dry-land dredging as it is termed—that is to say, the dredging of auriferous alluvial flats and ancient river beds. In such claims thorough prospecting by means of boring is simple and is easily accomplished before going to the expense of a dredge. The exact nature of the ground to be worked, the depth of the wash, and the richness thereof can be ascertained to a nicety. Want of water is often a serious drawback to such ventures, but where a small creek or stream is available and a dam is built, this difficulty is overcome. One great advantage which dry claims possess over river claims lies in their immunity from floods in spring and summer time, often the cause of temporary delay to river dredging. The Evans Flat and the Tuapeka dredges are both working old alluvial diggings with satisfactory results. Both machines are good examples of their class, being small, well built, and inexpensive to work. Cost of construction in each case was under £2,500, and their present average returns are about 25 ozs. each per week, while their working expenses are covered by 7 ozs. per week. Notwithstanding the success of dredging in Otago, the dredge of to-day has by no means reached perfection, and there remain many difficult engineering problems to be solved before a certain class of claims can be considered thoroughly worked out and all payable gold therein extracted. Take, for example, a gorge claim

McEachen, Photo., Alexandra.

A PORTION OF THE HARTLEY AND RILEY CLAIM.



DREDGE BUCKETS. THE PAST AND PRESENT IN NEW ZEALAND.

situated on a swift running river like the Molyneux. The bottom may be rocky and uneven, and with the present style of round-lipped buckets, however large, it is impossible to secure the heavy gold which lies hidden in the crevices and holes of the bed rock. Years ago, before dredging was thought of and when the river was comparatively free from drift, the miners took many pounds' weight of gold from seams and cracks in the rock-bound claims, following these cracks down until it was impossible to venture further. To-day these same fissures lie hidden under 20 ft. of drift, which covers up untold quantities of the precious metal and only waits some ingenious engineering contrivance to bring the gold to light.

The invention of the suction dredge, would, it was thought, make the dredging of rough-bottomed claims an entire success; but, although twenty dredges of this description have been placed upon claims in New Zealand, none of them has proved a financial success.

During the next twelve months we may reasonably expect to see a considerable expansion of the dredging industry, as in that time many machines now in course of construction will be at work.

The returns have proved, and are proving, so satisfactory that the public are readily subscribing a large amount of capital, the result being a tendency to build larger and more powerful dredges, capable of dredging to greater depth than formerly, and also of lifting and treating a larger quantity of wash dirt.

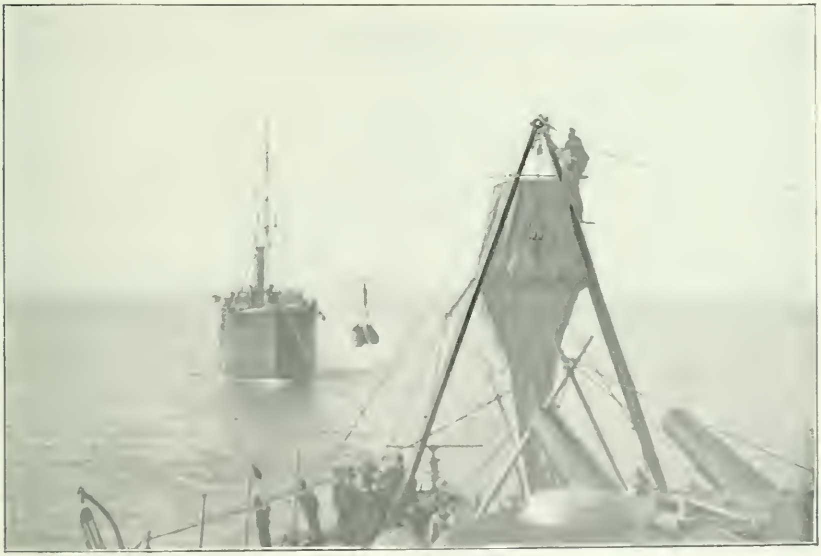
THE PROBLEM OF COALING WARSHIPS AT SEA.

By Spencer Miller.

On May 24th, 1898, the following telegram was sent from Admiral (then Commodore) Schley to Admiral Sampson: "Coaling off Cienfuegos is very uncertain. Having ascertained that the Spanish fleet is not here I will move eastward to-morrow, communicating with you from Nicholas Mole; on account of short coal supply in ships cannot blockade them if in Santiago. I shall proceed to-morrow, 25th, for Santiago, being embarrassed, however, by Texas' short coal supply, and our inability to coal in the open sea. I shall not be able to remain off that port on account of the general short coal supply of squadron, so will proceed to vicinity of Nicholas Mole, where the water is smooth, and I can coal the Texas and other ships with what coal may remain in collier." Probably no message was ever received by the U. S. Navy Department which more thoroughly emphasized the importance of an apparatus which would coal vessels at sea. One year and a half later an experiment was made off Sandy Hook with an apparatus to coal at sea which gave rise to a remark by Captain C. J. Train, of the U. S. S. Massachusetts, who had just witnessed a day's rough-weather trial of the apparatus: he said: "There was no time during the Cuban blockade of last year when this system could not have been used. I consider it a great success. It proves the system capable of supplying coal in almost any weather that is fit to coal ship."

Admiral Schley's message of desperation was written while attempting to bottle up the only Spanish fleet present in American waters. It is difficult to imagine what might have been dispatched if the "Flying Squadron" had visited the coast of Spain. Imagine a fleet arriving off the enemy's coast, with its coal bunkers practically empty, and unable to coal at sea. The advantage would lie with the enemy, putting out from home ports with bunkers well filled. The programme would be, of course, first to capture a base where colliers could lie and warships have their bunkers replenished. But the capture of such a base might result in the loss of a ship, and, even though it did not, the campaign of attack would be hampered by the necessity of maintaining a defense of the colliers, especially against torpedo-boat attack. This point is made doubly important since the submarine torpedo-boat has proved a success. In contrast to this, imagine that each collier is fitted to coal at sea and under headway. Not only would the attacking fleet arrive with bunkers filled, but the colliers, being able to remain at sea, would stand less in peril of torpedo attack.

The late Vice-Admiral Colomb recently said: "The superior American navy makes no attempt to carry the war into European waters as Great Britain in 1812-14 carried it into American waters. It is incapable of watching European Spanish ports, and Spanish ships are free to come and go out of them as though there were no war. The American ships, arriving on the Spanish coast, could not begin the blockade of Cadiz until they had filled up with coal, and that coal must either have preceded them or have been brought over with them in colliers.



THE MILLER CONVEYOR FOR COALING AT SEA, INSTALLED BY THE LIDGERWOOD MFG. CO.

The view, taken during the smooth water tests, shows the quarter deck of the Massachusetts with shear poles and chute, the collier Marcellus in tow, and the sea-anchor conveyor lines with coal bags in transit. The man at the shear head hooks the empty bags on to the returning carriage.

Again, Vice-Admiral Colomb said: "Cervera steaming past Martinique might have steered straight for Santiago, might have sent a destroyer in for intelligence, and might have gone on to strike his blows as indicated. Why did he let his whereabouts be known at Martinique when he might have run past at night and nobody the wiser? Why did he again show himself at Curaçao, and why did he pass into Santiago without attempting anything? The only plain reason we can adduce for what took place is the question of coal supply."

The importance of the question increases directly as the increase of sea-power, and with the probability of fighting naval wars far from home shores the ratio rises enormously. England's first line of defense is said to be the enemy's coast. She is well supplied with coaling stations all around the world. But, were she blockading foreign ports, how large a portion of the blockading fleet would be worse than ineffective, because itself subject to possible attack by superior force while steaming between blockade and coaling station? The greater the distance to the coal, the greater the number of vessels continuously off station, and, with Guantanamo only forty-five miles away, only three-fourths of the American ships could be kept actually on blockade service. Germany fully appreciates the necessity of an apparatus for coaling at sea, as indicated by the statement of Rear-Admiral Pluddeman, who said recently: "It will be absolutely necessary in future to take coal from a collier at sea."*

Nor is the desirability—nor, I believe, the possibility—of mechanical transport from ship to ship confined to the transfer of coal. Why can not provisions and ammunition be also transferred from one ship to the other at a safe distance? And does not this possibly indicate a new type of ship for the use of navies, which might be called a "general-supply ship, carrying in its hold everything a warship needs, and equipped not only to transfer its cargo at sea, but in port as well?

The problem of building a marine cableway is one that has received a great deal of attention for a number of years.† The first suggestion of such a device was made by Lieutenant Bell, of the British navy, in 1887, and his plan involved the use of a suspended cable, running from a mast on the stern of the warship to the foremast of the collier in tow, and used for the transferring of coal. This apparatus was never tried, for it was appreciated that it would have utterly failed, as Lieutenant Bell had made no provision for the relative motion of the boats. No such apparatus will ever succeed in coaling at sea that does not involve in its design some sort of compensating device, whereby the suspended cables are held under uniform tension in spite of the pitching and tossing of the vessels. The same criticism applies to the scheme proposed by Lieutenant R. G. O. Tupper, R. N., which, in substance, contemplated the use of an endless rope, with suspended buckets of coal at frequent intervals, operated by a capstan.

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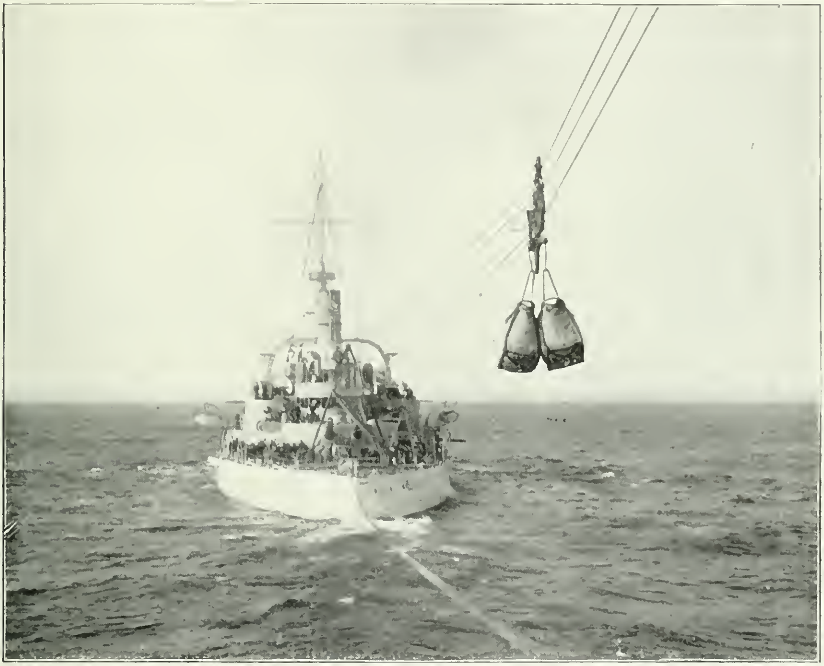
* Notes published by the U. S. Bureau of Naval Intelligence, Washington, Dec., 1898.

† For a full review of the history of coaling vessels at sea, including amplified explanation of the devices here described, see the author's paper before the Society of Naval Architects and Marine Engineers, N. Y., Nov. 16-17, 1899.

As I am dealing wholly with the problem of open-sea coaling, and not with harbor or smooth-water operations, I need make no mention of the Temperley transporter, so largely used in the British navy, nor of any other plan involving side-by-side positions. Vessels cannot be brought broadside-to, even in the most moderate sea.



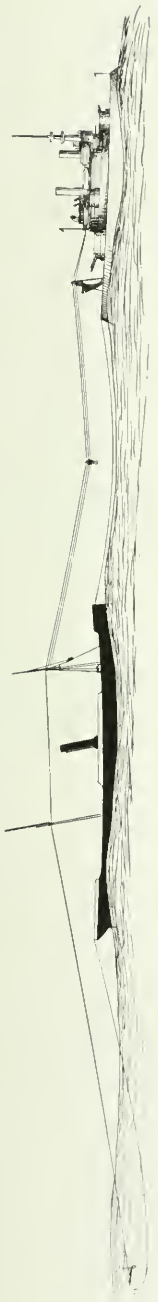
STERN VIEW OF THE U. S. S. MASSACHUSETTS COALING AT SEA.

She is towing the collier at a speed of six knots. The load—840 lbs.—is going toward the warship at a speed of 1,200 ft. per minute.

The first experiment tried by the United States war vessels was that of Philip B. Low, and the trial was made in 1893, when an inclined cable, attached to shear poles on the towing vessel and led over a "gin block" at the masthead of the collier, was held under tension by a counterweight moving up and down between the deck and the masthead. The loads traveled by gravity from collier to warship. The plan patented by John E. Walsh, of New York, while more elaborate, also depends upon a counterweight to compensate for the irregularities caused by the diverse pitching and rolling of the ships. Such a compensator may work in a smooth sea, and the device may transport a small amount of coal, but the experience gleaned in the recent experiments off Sandy Hook proves conclusively that such a device would be a total failure in seas of any magnitude. One little experience alone will demonstrate that. During the operation of transferring coal on December 23, 1899, the tow line suddenly slipped, and before it could be secured some forty feet had been paid out. Such a slip, with a counterweight at the end of the cable, would probably have resulted in breaking the cable, followed by the falling of the counterweight, or else the unshipping of the foremast. In the apparatus tested this slip was not even noticed by those on the Massachusetts, the lines instantly adjusting themselves.

Just before the breaking out of the Spanish-American war, in March, 1898, Mr. J. J. Woodward, naval constructor, U. S. N., located at Newport News, Va., sent to the Lidgerwood Manufacturing Company, of New York, an outlined plan for coaling a warship from a collier in tow, by means of a suspended cable, asking for a plan and a proposal. He foresaw the experience indicated in Commodore Schley's letter. His inquiry was referred to the author, who immediately set to work in earnest to design an apparatus to fulfill the conditions specified. On May 11, during the war, a proposal was laid before Admiral Bradford, chief of the Bureau of Equipment of the United States navy, which proposal and its accompanying plans were referred to a board which Secretary Long had especially appointed to consider devices for coaling at sea. On May 20th the board brought in an adverse report, whereupon the plans were revised, and again submitted to the same board on June 17th. This plan was promptly considered and reported upon to be "feasible in moderate weather." Although the navy department at that time had full knowledge of the difficulties encountered by Commodore Schley, it still required several weeks to obtain from the department such a contract as the builders could or would proceed to execute. On July 22d the proposal was accepted, and the collier Marcellus was named to be fitted with the apparatus.

The sudden termination of the war made unnecessary the hurried execution of the contract that had been anticipated. The apparatus was not completed until November 20, 1898, The collier Marcellus was then needed for service, hence the apparatus was not installed until Septem-


Sea Anchor.
Marcellus.
—300 to 400 feet—
Massachusetts.

U. S. COLLIER MARCELLUS DELIVERING COAL AT SEA TO THE U. S. S. MASSACHUSETTS.

Towing speed five to six knots; loads 840 lbs.; conveyor speed 1,206 ft. per minute; actual capacity 20 to 24 tons per hour.

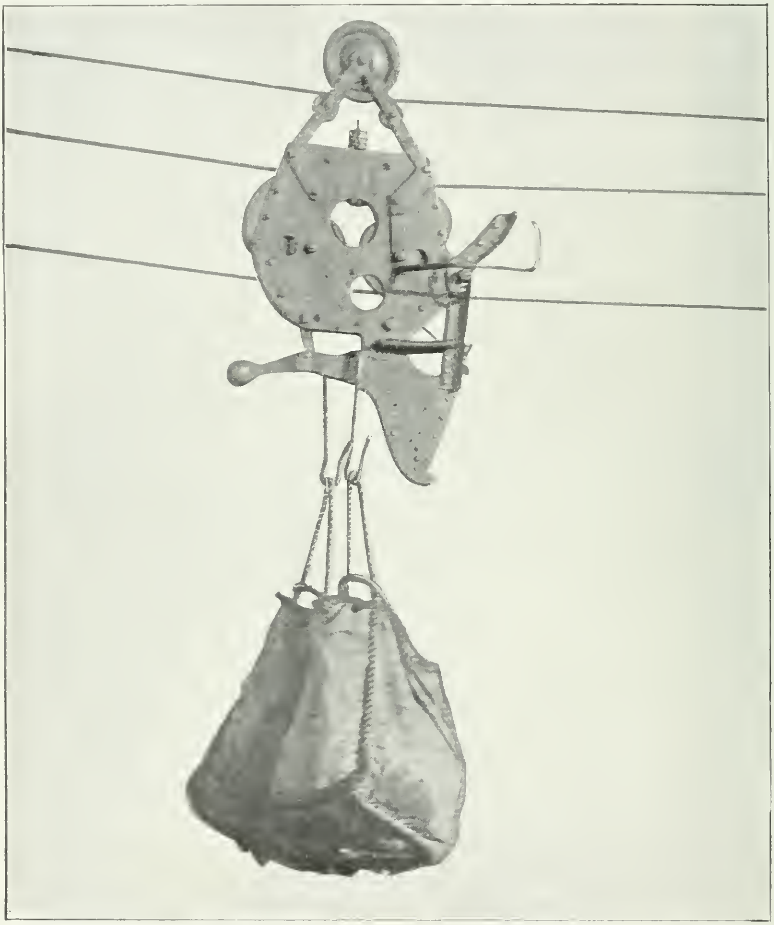
ber of the following year. During the spring months of 1899 the apparatus was set up on land, perfected, and several demonstrations were made before naval officers, whose opinions were sought as to the practicability of the apparatus. Among these were Rear Admiral W. T. Sampson and Commander Raymond P. Rodgers, both of whom expressed a most favorable opinion of the apparatus, and Naval Constructor F. T. Bowles, of the New York navy yard, who did not hesitate to say, when asked by the then acting secretary, the Hon. Charles H. Allen, that the apparatus in his opinion would fully meet the requirements of the contract.

The contract with the department specified that the apparatus should safely transfer coal in bags from collier to warship at a rate of not less than 15 tons per hour, in a moderate sea and weather, and with a distance not less than 300 feet between ships.

The apparatus in its final trial transferred over 20 tons of coal per hour, in a sea a little heavier than moderate, with a distance of about 400 feet between the ships.

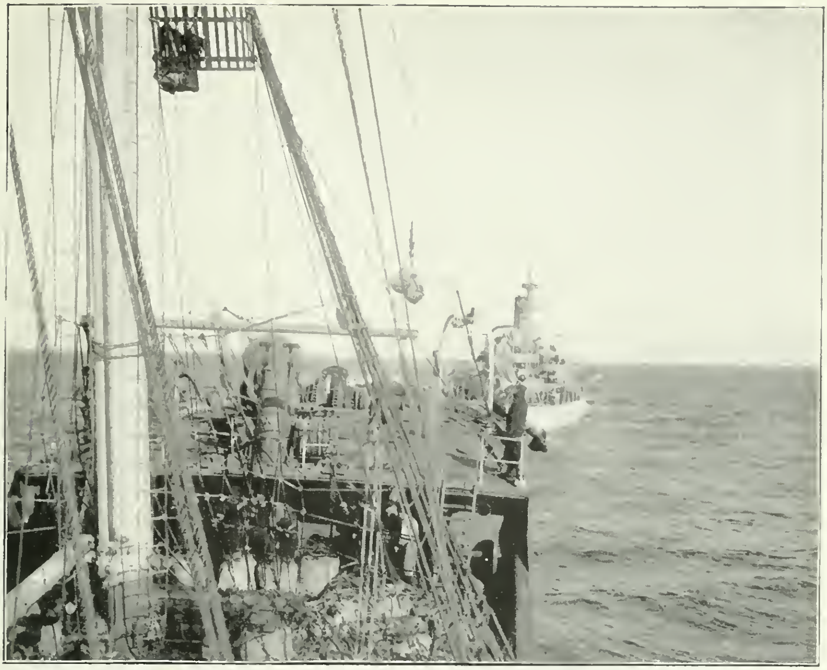
An engine, (see page 717), with double cylinders and double friction drums of special design, was located just abaft the foremast of the collier. It had two steam cylinders 12 in. by 12 in. A 3/4-in. diameter steel rope was led from one drum over a pulley at the masthead, and thence to a pulley at the head of shear poles on the warship and returned to the other drum.

The engine moves in the same direction all the time and tends to wind in both parts of the conveying rope. One drum hauls in its part of the rope and the other pays it out under tension by the slipping of the drum. A novel form of load carriage is supported by this rope. It is provided with a grip on the upper part and wheels to run on the lower part. This carriage carries two loaded bags weighing 420 lbs. each, suspended from a bale which hangs in a hook below the carriage. An elevator takes the bags from the deck, hoisting them to the masthead. The conveyor carriage, in coming in to the masthead, locks itself under the bale. As soon as the bale is released (by a man stationed on the trestletrees) the engine operator hauls in the lower part of the conveyor line. The upper part of the conveyor line is thereby drawn from the rear drum, slipping the specially contrived friction devices. Thus the carriage crosses from collier to warship, the tension being sufficient to insure the bags clearing the water between the vessels. The rope is drawn in at a speed of



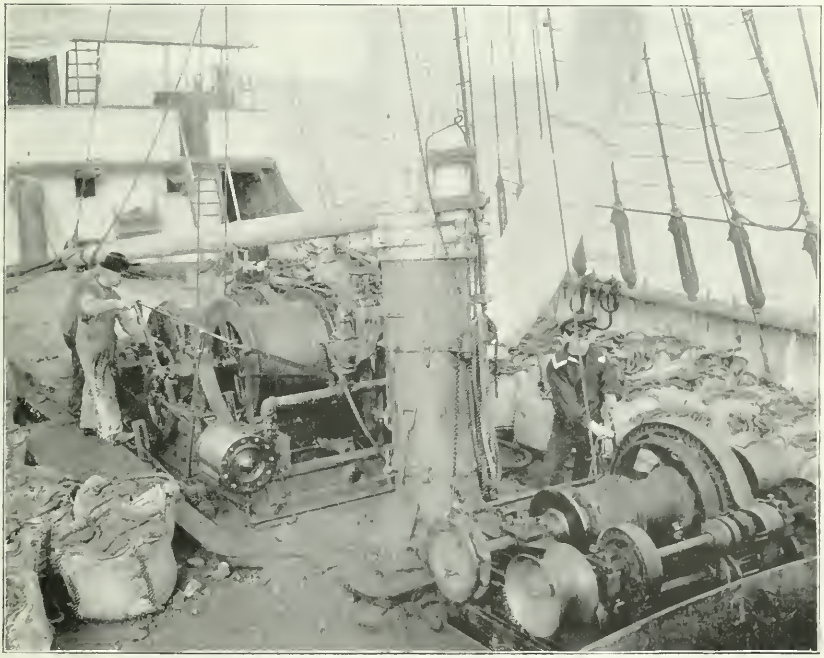
CARRIAGE WITH LOAD OF 840 LBS. IN TRANSIT.

The upper rope is the sea-anchor line; the two lower ropes are the conveyor line.



FORECASTLE OF COLLIER MARCELLUS, DELIVERING COAL AT SEA TO U. S. S. MASSACHUSETTS.

Two bags are shown in transit. The elevator on the collier is descending with empty bags.



ENGINE FOR THE MILLER CONVEYOR SYSTEM.

Cylinders 12x12; drums 36-in. diameter; speed of rope 1,000 to 1,500 ft. per minute. The forward winch is used for hoisting the bags on the elevator to the masthead.

1,000 ft. per minute, and, if the points of support (masthead and shear head) do not vary, the upper part will be drawn out, under tension of about 3,000 lbs., at the same rate of speed. If, however, the distance is increased during the transit of the load, the extra rope called for will be given by the slipping of the upper part from the drum. This will increase the speed of the upper part. On the other hand, if the ships reduce the distance between points of support, the speed of the upper part will be reduced.

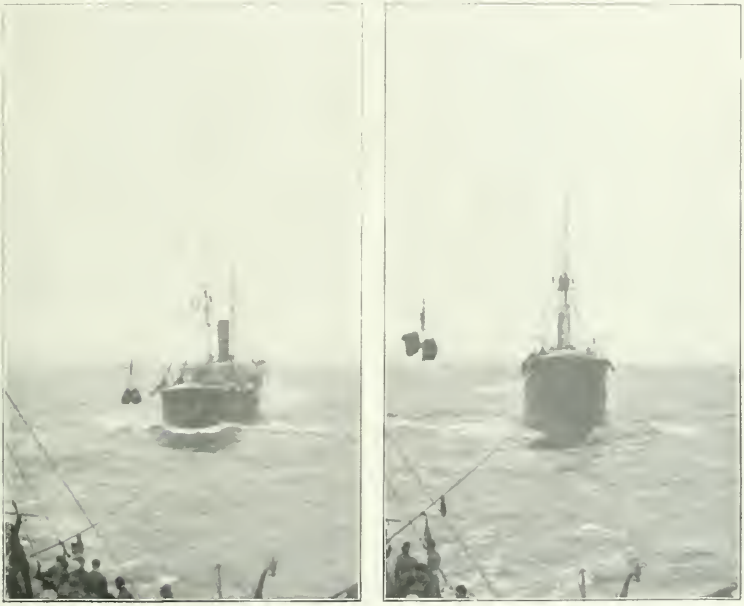
Thus, it will be observed, speed is an element of compensation. The speed, therefore, must be more than twice that at which the points of support can approach or recede from one another, in order to compensate perfectly for the relative motion of the ships.

When the carriage reaches the pulley at the shear head it collides with it (at reduced speed of course) and thus striking, releases the lower hook, and the two bags and their bale drop into the canvas chute and slide easily to the deck of the warship. Loads drop in this manner at the rate of one per minute. The empty carriage is drawn back by the rear drum, the forward drum being thrown out of friction.

An auxiliary rope known as the "sea-anchor line" is stretched above the two parts of the conveyor line and under a pulley on the carriage. This rope is attached by a "knock-off hook" to the superstructure of the warship, and rests in a "saddle" on the shear head; thence it leads through the carriage, over pulleys at the head of the foremast and mainmast of the collier, and on astern several hundred feet to the sea. On the end of this rope, a drag or "sea anchor" is attached, made of canvas in the form of a cone. This sea anchor is selected in reference to the speed with which the ships are to travel. In a smooth water test, speeding at six knots, a drag 7 ft. in diameter at the base was used. During the rough-weather trial, the same anchor seemed to give the required tension at five knots.

This line is to support the carriage when empty, on its return to the collier. It permits the conveyor line to be slack and prevents the overturning or twisting of the carriage. Doubtless at times it helps also to support the load in transit across, but photographic views, taken during the passage of the load, show the sea-anchor line slack, thus demonstrating that the tension device on the conveyor line is sufficient to sustain the load at a sufficient elevation during its transit.

About twenty men on the collier fill the bags and deliver them to the forward deck, and sixteen more take the bags to the elevator. In order that the operation may be carried on continuously the empty bags must be returned. This is accomplished by stationing two men in "crows' nests" at the shear head of the warship to hook the empty bags onto the side hooks on the carriage. Two other men at the masthead of the collier receive the bags. These are then placed on side hooks of the elevator and sent to the deck. The entire operation is continuous, and no delay is caused by hooking on or unhooking the bags.

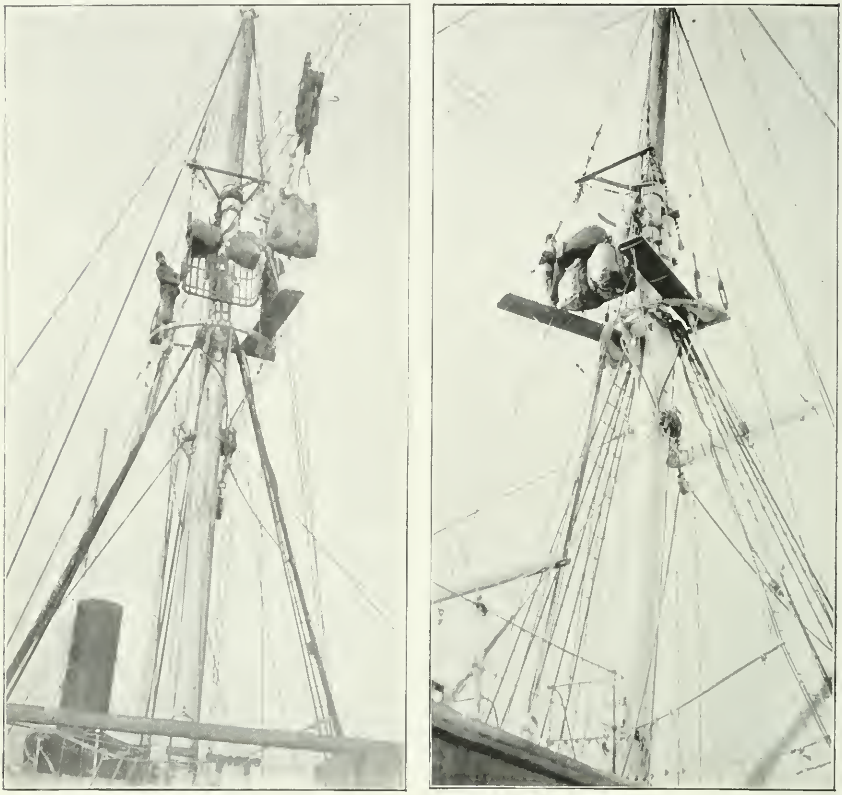


COALING IN A HEAVY SWELL. SPEED 6 KNOTS. HOURLY CAPACITY 21 TONS

On the left the Marcellus is plunging; the loaded bags are in transit to the warship. On the right the Marcellus is rising; the sea-anchor line is taking the weight of the carriage with empty bags.

At 300-ft. distance between the ships, even in smooth water, the collier Marcellus followed badly, and when over 7 degrees out of her course the operation was stopped. In spite of stops, however, 20 tons per hour were delivered. During the rough-weather trial, however, and with about 400 ft. between the ships, the collier followed perfectly, and no time was lost.

The apparatus had five sea trials. On the first day adjustments were made and 9 loads only were sent over. On the second day more adjustments were made, and a run of 38 loads in 38 min. and 40 sec. was suddenly terminated through the lack of skill on the part of the operator, who allowed all the rope to be coiled on the forward drum. This slipped the clip on the end of the rope through the other drum and the rope fell into the sea. No damage was done, no one was hurt,



AT THE MASTHEAD OF THE COLLIER.

In the view at the left, the carriage with suspended bags is just leaving the elevator on its journey to the warship. At the right is shown the elevator with loaded bags waiting for the conveyor carriage. The man on the platform takes off the empty bags on the returning carriage.

and the only penalty of such an accident was an hour's delay in rigging up again. On the third day, in one hour the apparatus transferred about 22 tons, and the work would have been continued longer but for lack of sufficient crew to fill the bags.

The navy department then ordered an endurance test of not less than four hours' duration, and a rough-weather trial as well.

Between the third and fourth trials some trifling alterations were made. The fourth trial lasted four hours. 75 tons were handled in 3 hours and 43 min. The water was smooth, with a ground swell. In the fifth test—the rough-weather trial—80 trips were made in 80 minutes. The performance could have been continued for an indefinite time, but the board being satisfied, there was no object in going further. One hour and a half was consumed in securing the tow line and setting up the apparatus.

The boats steered at first head on to the sea. The forecastle of the Massachusetts was washed at every plunge, and no coal could have been delivered there, even if desired. A little more than 20 tons were handled in an hour. The course was then changed quartering on the sea, and the results were the same. Then the boats steered in the trough of the sea and the rolling did not affect the working. The speed was maintained at about five knots. The Massachusetts burned about 3½ tons of coal per hour during the trial, thus gaining 16½ tons.

It must be borne in mind that it was a naval man, Naval Constructor J. J. Woodward, who requested plans for a marine cableway to coal at sea. He saw that the problem was that of modifying the cableway to fit sea conditions. The engineer, designing an apparatus to meet a new condition, must need to consult men versed in the field in which such device is to be used. So the designer of this apparatus, a landsman, sought the advice of many naval men, notably Chief Engineer Robt. Potts (retired), U. S. N., and Mr. F. T. Bowles, naval constructor, and Mr. Wm. Anderson, chief boatswain. Mr. Anderson, by permission of Assistant Secretary Allen, was employed to take charge of the trials, and his handling of the device and the men was so satisfactory that the designer had nothing to say during the last two trials.

Captain C. J. Train, of the U. S. S. Massachusetts, offered every assistance in his power to secure for the device a fair and sufficient trial. The same may be said of all the officers of both ships. The trial board, consisting of Commander A. B. H. Lillie, Lieut. John B. Bernardou, Lieut. W. R. Rush, and Warrant Machinist Biggs, also showed the greatest attention to all the details of the device, and their report is a faithful account of the trials.

Eleven ships were blockading Santiago—but when the Spanish fleet came out three were absent off station "coaling ship." They were at Guantanamo, 45 miles away. In the United States civil war, one-quarter of the vessels blockading Charleston, S. C., were alike away continuously coaling in smooth water. Thus we see, at Santiago, $5,000,000 worth of United States war vessels useless at the great crisis—and all because the colliers could not deliver their coal at sea. Can it be disputed, therefore, that the fighting efficiency of a blockading fleet will be increased by one-third, if waited upon by colliers capable of coaling at sea?

THE PRODUCTION AND UTILIZATION OF SUPERHEATED STEAM.

By R. S. Hale.

THE simplest and most usual method for producing superheated steam is to expose the saturated steam in a suitable vessel to the heat of the gases from the furnace, and practically any form of vessel can be made to serve for this, just as any form of vessel will serve as a boiler, and the qualities that make a good superheater are much the same as those that make a good boiler.

There are, however, a few points about superheaters that require special consideration in addition to the usual considerations governing boiler design, and the most important of these is the question whether the superheater should be located directly over the furnace, in the flue, or in an intermediate position. The old-fashioned method was to place the superheater in the flue exposed to the waste gases, and this position has the advantage that there is but slight danger of injuring the superheater by over-heating. On the other hand, placing the superheater in the path of the waste gases requires a very large area of superheating surface, since the waste gases are already comparatively cool, and cannot be cooled by the superheater below the temperature of the superheated steam; the combination of the boiler with the superheater in the flue is, therefore, an inefficient one for the production of steam. Further, this position of the superheater makes the temperature of superheat comparatively irregular, and in consequence of these objections the trend of the best practice of to-day is decidedly against placing the superheater in the path of the waste gases. Instead, considerable progress has been made toward the adoption of the position which seems theoretically best for the superheater in order to make the combination of boiler and superheater most efficient, viz., directly over the furnace fire, so that the hottest steam, which is the superheated steam, shall be exposed to the hottest gases. Since the furnace of the boiler itself would be so hot as to burn the superheater, a separate furnace for superheating must be provided, and such a furnace, besides being inefficient on account of its small size and of the high temperature at which the gases must leave it, is also comparatively expensive, since it is a special installation, and requires special attention and care in order to keep the temperature of superheat uniform. As a consequence, neither the path of the waste gases nor the separate furnace appears to be as advantageous a place for the superheater, in practical work, as the intermediate position. For example, if a superheater for a Babcock & Wilcox boiler is placed between the tubes and the drum, the gases surrounding the superheater are sufficiently cooled by the first pass through the tubes to avoid serious danger from over-heating, and are yet so hot that but a comparatively small area of superheating surface is required. Then, after the gases have been utilized for superheating, their heat is further utilized by the remainder of the boiler-heating surface, so that the combination of a boiler and a superheater in this position is as efficient for the utilization of the heat of the coal as a boiler alone—in fact, more efficient. It is clear, therefore, that this position is in general the best one, although, of course, special considerations may make the separate furnace or the location of the superheater in the flue better for some plants.

Another special consideration appertaining to superheater design, as distinct from boiler design, is the need of a very swift circulation in types of superheater that are exposed to very hot gases, because of the possibility of overheating. Although the velocity of the steam is usually sufficient when the boiler is working, yet when steam is being raised there is no circulation in the superheater, while at the same time it is surrounded by very hot gases. It is therefore necessary with some types of superheater to provide means for flooding the superheater with water while steam is being raised. With other types of superheater this does not appear to be necessary.

Other questions of superheater design differ but slightly, if at all, from the questions that come up in boiler design proper, a fact which is brought out by a comparison of the different forms of superheater with well known boiler types. For instance, we have the old-fashioned steam chimney for superheating, corresponding with the old-fashioned shell boiler without tubes. The Gehre superheater is built almost exactly like a fire-tube boiler. The Uhler superheater consists of Field tubes, *i. e.,* one tube inside of and concentric with another, a form of construction that has often been used for boilers. The superheaters on the U. S. SS. Georgeanna and Adelaide, described in Isherwood's "Researches of Steam Engineering," correspond to the water-tube boilers using straight tubes, while the Musgrave and Dixon superheater, or its practical equivalent, the Babcock & Wilcox, uses U-tubes expanded into cross-boxes, and corresponds to the various water-tube boilers using bent tubes.

Outside the patent-office records, the only superheater of to-day that differs markedly in design from any type of boiler is the

Schwoerer. This superheater consists of heavy cast-iron tubes, ribbed externally and provided internally with transverse baffle-plates. The use of cast iron at high temperatures and high pressures is a marked innovation, but the use of very thick metal appears to give absolute safety, since it is reported that these superheaters have been run red-hot without sign of trouble, and certainly the reports of the boiler-insurance companies in France and Germany, where these superheaters are used, seem to show no difficulty with them. So far as I can learn, this superheater is not injured if the steam is delivered directly to the pipes without passing through the superheater, in case it is desired not to use the superheater on account of injury or other reason, while with most superheaters (except, of course, those in the flue or over a separate furnace) the superheater will be spoiled unless steam is kept passing through it at all times when the boiler is in service. Its use would enable the boiler to be tested with and without the superheater in operation, a thing that would be impossible to do, without injury, with other types of superheater when placed in this position; it would also prevent injury if steam is raised without flooding the superheater. The ribbed surfaces and the internal baffle-plates make the tubes very efficient for the transferring of heat, so that a small superheater is effective in superheating a large quantity of steam.

While superheating by means of the gases is the simplest and most usual method, two other methods have been proposed, to which brief reference may be made. One of these methods consists in generating steam at high pressure and then superheating it by wire-drawing it to a lower temperature. For instance, steam might be generated at 500-lbs. pressure and then wiredrawn to 150 lbs. It is not necessary to give the calculation, but it suffices to say that the maximum superheat to be thus obtained is only about 70° F. if the steam is absolutely dry, whereas if there be only 3½ per cent. moisture in the steam at 500 lbs., the heat which would otherwise superheat the steam serves to dry out this moisture and practically no superheat will be obtained. An initial pressure of 500 lbs. is an extreme case, and in the case more ordinarily proposed, of generating steam at, say, 200 lbs. and then wiredrawing it to 150 lbs., the superheat obtainable will be only 20° if the steam is dry, and none at all if the steam contains 1 per cent. or more of moisture. Now, since high-pressure boilers are more expensive to build and less efficient in operation than low-pressure boilers, it is clear that it will not be good practice to generate steam at a high pressure and then to wire-draw for the sake of obtaining such a slight degree of superheat at a lower pressure.

Another very interesting method of superheating steam is described in some British patents of recent years. In consists in passing the steam through coils of pipe surrounded by a liquid of high boiling point, as, for instance, mercury or oil. The liquid is heated by a separate furnace or by the boiler gases, and it is obvious that none of the apparatus can rise in temperature more than a few degrees above the boiling point of the liquid, a fact which makes the apparatus safe from over-heating, while the superheated steam will be given a regular temperature. While this method gets rid of the difficulties inherent in any apparatus which has hot gases on one side and hot steam on the other, it does not appear ever to have been put into practical operation. Possibly the difficulty has been to find a suitable liquid, since mercury would be too expensive and any oil would be subject to the danger that it might give off explosive gases. High-pressure steam might be used as the liquid, but this would introduce the difficulties of generating and handling high pressures, although it would have the advantage over ordinary superheaters that it would avoid the necessity of having a vessel with hot gases on one side and hot steam on the other, since the high-pressure generator need not have any superheating surface. If, however, the high-pressure steam must be generated in any case, the method appears to be a good one, and, in fact, high-pressure boiler steam is the vehicle used for superheating the low-pressure steam in the receivers of a compound or triple-expansion engine.

It is clear, therefore, that the simple and direct method of utilizing the furnace gases by a superheater placed in the first pass of the gases, where they have been cooled sufficiently to avoid danger of over-heating the superheater and are yet so hot that only a small area of superheating surface is required, will probably represent in the future, as it does now, the best practice of superheating high-pressure steam, while high-pressure saturated steam itself will be the best means for superheating low-pressure steam. In regard to the type of superheater to be used, it will probably be many years before we shall be able to say that any one type—the Musgrave and Dixon, the Gehre, the Babcock & Wilcox, or the Schwoerer—is the best, any more than we can to-day say that any one type of boiler is better than another. Some types of superheater now used will be found impracticable and new types will appear, but the choice between the types will depend on their first cost, on the cost of their maintenance, and on their freedom from trouble in practical operation—questions which cannot be decided by any theoretical considerations.

We may, therefore, take up the second branch of our subject, the utilization of superheat, and before discussing the saving to be expected when superheated steam is used in an engine, it will be well to point out that superheated steam for heating purposes has no practical advantage. It is true that when first turned into the pipes it is hotter than saturated steam, but it loses this extra temperature and becomes saturated steam of lower temperature in a very few minutes. It is more expensive to produce than saturated steam and may give rise to difficulties on account of its irregularities of temperature, so that it is safe to say that it should never be produced for heating purposes.

The chief, and practically the only, use of superheated steam is in engines, and here the superheat operates to diminish the waste known as initial condensation—a waste caused by the cold walls of the cylinder. The amount by which superheat reduces this loss has varied greatly in the different experiments. Isherwood, in his "Researches of Steam Engineering," volume 2, preface page 28, states the saving as 33 per cent. for 135° F. superheat, or a gross saving of 5 per cent. for each 20° F. superheat. Thurston, Transactions of the A. S. M. E., 1896, page 551, gives the average saving of fifty-two tests as 26 per cent. for an average superheat of 105° F., or 5 per cent. for every 20° F. It is not clear whether this is the gross saving or whether it is the net saving after allowing for the 1 per cent. extra heat required to superheat steam each 20° F.* Barrus, Boiler Tests, page 23, gives the gross saving as 2 to 3 per cent. for each 20° F. A number of recent German and French tests averaged 3 per cent. for each 20° F. The average of the five tests actually quoted in Thurston's paper above referred to, is 4 per cent. for each 20° F. Ripper, Proc. I. C. E., 1897, gives some very careful experiments showing a gross saving of from 3.2 to 3.6 per cent. per 20° F. In all the cases, the per cent. saving is taken of the quantity of saturated steam used, *i. e.,* of the larger quantity.

The superheat in these experiments ranged from a few degrees to 350° F., and the saving per 20° F. appears to be about the same for all degrees of superheat. This is contrary to the usual idea that the proportionate saving is greater for small degrees of superheat, but the experimental evidence points strongly towards the saving being proportionate over the whole range from no superheat to 350° F. superheat. It is possible that the idea that the first few degrees of superheat are of special advantage arose from experiments in which steam superheated a few degrees was compared with saturated steam containing moisture which was not allowed for. Of course, if the moisture in the saturated steam is not allowed for, the saving per 20° F. will be abnormally large for small amounts of superheat.

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* Of course this figure is approximate.

The average of this large number of experiments is almost exactly 4 per cent. gross gain for each 20° F. superheat, or a net gain of 3 per cent. after allowing for the 1 per cent. of heat necessary to superheat steam 20° F. This is probably a safe average figure, although, of course, an average figure does not necessarily represent any particular set of conditions. It is clear that the saving exists, and in spite of incidental losses when superheated steam is used, such as extra radiation and extra leaks, it is almost certain that there are many plants where superheated steam will pay a good net return on the first cost of the superheater. It is also clear that, up to a limit of 675° F. temperature, the higher the temperature of the steam, the greater will be the total saving.

In the discussion of methods of superheating above given, reference was made to the use of coils surrounded by high-pressure boiler steam for the purpose of superheating low-pressure steam in the receivers of a compound or triple-expansion engine. The figure just given as the probable saving for each 20° F. of superheat may probably be used safely in computing the saving obtained by superheating receiver steam in this manner. Let us assume that we have a compound engine taking saturated steam at 125-lbs. pressure, or 350° F., doing the same amount of work in each cylinder, and using 15 lbs. of steam per i.h.p. per hour. Each cylinder, therefore, may be considered a simple engine using 30 lbs. of steam per i.h.p. per hour—or, putting it in another way, each 300 lbs. of steam that goes through the engine does 10 h.p. in the high-pressure cylinder and 10 h.p. in the low-pressure cylinder. Now, let us assume that the steam in the receiver has a pressure of 15 lbs. The temperature of saturated steam of 15-lbs. pressure is 250° F., but, if the receiver steam is superheated by jacketing it with boiler steam, it may be raised to 350° F., the temperature of the boiler steam, which makes a superheat of 100° F. This will require approximately 5 per cent. more heat, or, instead of the 300 lbs. of steam per hour, it will require the boiler to deliver 315 lbs. of steam per hour. The gain, however, due to a superheat of 100° F. in the low-pressure cylinder, will be, according to the figure given above, approximately 4 per cent. for each 20° F., making 20 per cent. for the 100° superheat. The low-pressure cylinder, therefore, will be working at a water rate of 24 lbs. per h.p., instead of 30 lbs., so that the 300 lbs. steam will do 12.5 h. p., instead of

10 h.p. in the low-pressure cylinder. The net result, therefore, is that if we superheat the steam in the receiver we shall get 22.5 h.p. for 315 lbs. of feed water per hour, or a rate of 14 lbs. per h.p., instead of 15 lbs. per h.p. without superheating between the cylinders—a net gain of approximately 7 per cent. The same thing would hold true if the steam were superheated in the receivers of a triple-expansion engine, only the gain would be greater.

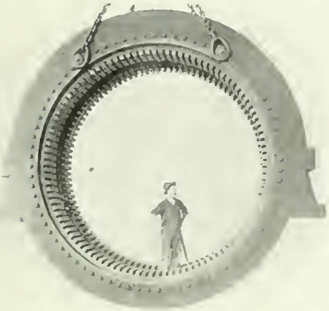
While the superheated steam shows these large savings, it is interesting and important to note that the saving is due to the higher temperature of steam at the same pressure, *i. e.,* steam superheated 100° F. shows a saving only when compared with saturated steam of the same pressure, which is 100° F. cooler. If, however, steam superheated 100° F. be compared with saturated steam of the same temperature (and consequently higher pressure), it actually shows a loss. For instance, take the case of the compound engine discussed above. The low-pressure cylinder, considered alone, has a water rate of 30 lbs. per h.p. for saturated steam of 15-lbs. pressure and 250° F. temperature, and a water rate of 24 lbs. per h.p. for steam of 15-lbs. pressure superheated to 350° F. Against this we have the fact that saturated steam of 350° F. (which would have 125-lbs. pressure) will give a water rate of 20 lbs. in a single-expansion engine, or 15 lbs. in a compound—a better rate than can be obtained by superheated steam of any pressure, unless the temperature exceeds 350° F.

The use of higher and higher steam pressures and temperatures has been advancing rapidly of late years. The obstacles to this advance have been largely obstacles due to temperature, and the ultimate limit to the increase is probably the limit of temperature where metals lose their strength, since in hydraulic and compressed-air work, where the difficulties of temperature do not enter, pressures of 1,500 and 2,000 lbs. are in practical use. It is possible, therefore, that some day (when accident insurance is cheaper) we may use steam pressures so high that the temperature of the saturated steam cannot be raised without danger of weakening the metal, so that superheat will no longer be available. This day, however, is far in the future, since we can use, and are using to-day, temperatures of 650° F., while steam of 500 lbs. has a temperature of only 467° F. and can be superheated 200° F., with a saving of 30 per cent., and steam of 1,000-lbs. pressure has a temperature of 546° F. and can be superheated 100° with a saving of 15 per cent. Steam of 500-lbs. pressure superheated to 650° F. may seem a good deal of a problem, but I believe it to be one of the probabilities of the future.

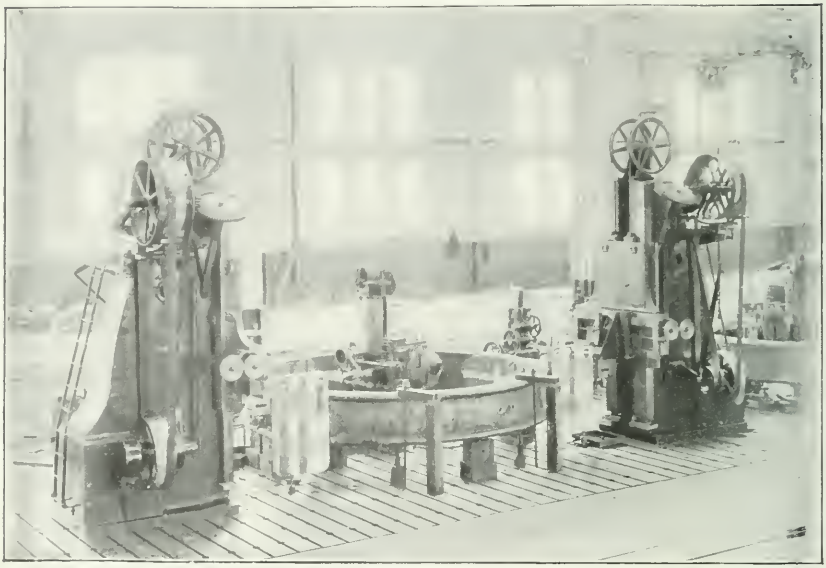
THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

V.—THE APPLICATION OF AUTOMATIC MECHANICAL PRODUCTION TO HEAVY WORK.



THE evolution of automatic and semi-automatic machine tools has naturally been limited, as shown in the preceding articles of this series, to work of comparatively small dimensions, sizes up to 10 or 12 ins. diameter having been about the largest handled so far, and no great effort has been made to place the finishing of heavy work in lathes, planers, boring mills, and traversing-spindle milling, drilling and boring machines of large dimensions in charge of specialized laborers. The flexibility of both cast iron and wrought steel, in large dimensions, makes skill and experience in setting and supporting large pieces in process of machine-tool finishing indispensable. In work of small dimensions, this factor of structural flexibility is so small that it need not be reckoned with; in work of large dimensions it must be anticipated and guarded against at every step and stage of machine tooling, if oval and eccentric lathe work and distorted finished plane surfaces are to be avoided in the completed pieces. It is true that the setting of large pieces in machines other than lathes has been very greatly facilitated by slotted sole plates of large dimensions, very carefully supported on ample foundations, in the case of the traversing milling and boring machines, and that work can be set on tables of the vertical boring mills with a far less expenditure of skill and labor than is required to support the same pieces securely and accurately on the large-lathe face plate; it is also true that, in the case of the special cylinder-boring machines which are mentioned hereafter in this paper, parallel and right-angle boring of holes in the same piece is assured by the introduction of separate added boring spindles; but great care, great skill, and great experience are required on the part of the workman to avoid distorting the



AN INSTANCE OF THE USE OF SLOTTED SOLE PLATE AND PORTABLE MACHINES IN THE PRACTICE OF THE GENERAL ELECTRIC COMPANY.

On the right and left are portable slotters, in the center a portable drill press, all electric driven. The tools are arranged for simultaneous working on heavy machine parts.

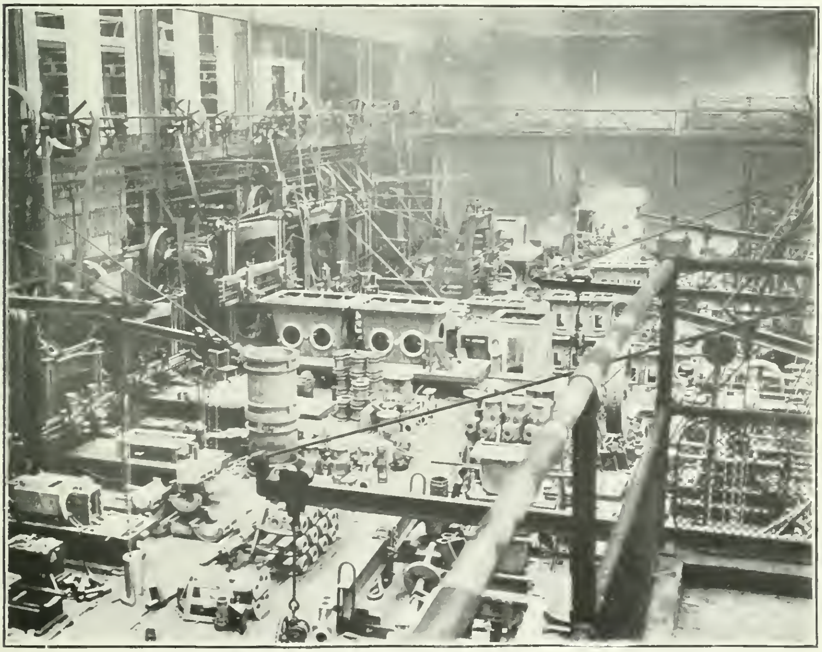
work by clamping it, or by failure properly to support it against the heavy cuts of the tools; besides this, the large cost and great importance of these large machine tools makes the item of a difference of a dollar or so a day in the attendant's wage a matter of small import, and there is no indication that large general machine tools can be successfully given in charge of any but the best and most experienced mechanics obtainable.

Another great barrier to the rapid spread of such practice is the commercial one. There are as yet but a limited number of cases affording opportunity for manifold exact repetitions of heavy machine parts. The progress of special tool-making must go step by step with that of the standardization of heavy work. At present it is, in American shops at least, probably quite as far advanced as the conditions of mechanical manufacture demand.

An example of the great differentiation which yet exists between light, or even medium, and heavy work, and a test of the correctness of my general conclusions as to ultimate machine-shop methods, is afforded by the inspection of advanced practice in machine-constructing which I recently had the opportunity to make in the Westinghouse shops. The contrast of methods and means is especially striking when it is made between the Westinghouse Air-Brake Company's works at Wilmerding and the Westinghouse Machine Company's establishment at East Pittsburg.

The limits of this paper forbid more than the briefest mention of a very few of the most striking peculiarities of the brake-shops practice, which is exactly in line in all essential particulars with my own conclusions and theories. Of the two thousand hands employed in the construction of work requiring fully the accuracy of good steam-engine construction, only about 10 per cent. are skilled mechanics. Work is produced in both the foundry and the machine shops at extremely low labor-hour costs, and the whole machine-shop special-tool equipment was constructed by well known makers, little or none of it being of home manufacture. The foundry is operated on an amplification of the turret scheme, endless chains of carriers about 230 ft. long being employed to perform most of the work.

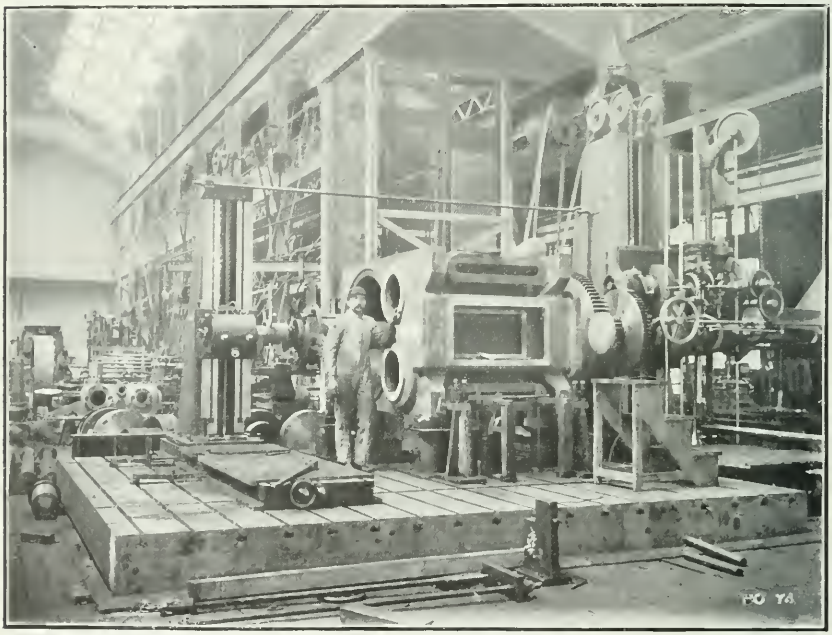
Mr. Welch's foundry inventions have reduced the cost of small machine moulding as much as the use of the turret has reduced the cost of machine-part finishing, or perhaps even more, as a very large part



HEAVY PLANERS, WESTINGHOUSE MACHINE COMPANY'S SHOPS.

of the hand moulder's time is occupied in operations which do not belong directly to mould-producing, while pneumatic moulding machines, in addition to the endless carrying-table chains, bring the Wilmerding mould-making costs to incredibly low figures.*

But turning to the Machine Company's shops, a totally different class of work is met. These shops which, when the additions now far advanced are completed, will have a floor area 1,500 ft. by 235 ft., with large gallery space in addition, are filled with tools of the latest and most improved description, and of a far heavier class than I was prepared to find in this establishment, which I had not visited since it was wholly devoted to the production of single-acting steam engines in comparatively moderate sizes, say not much exceeding a cylinder diameter of 20 in. Instead of this comparatively narrow line of medium-sized productions, the work in hand includes some of the largest and heaviest Corliss steam engines for generating electricity, building the Parsons steam turbine in large sizes, and the triple-cylinder gas engine in units as large as 1,500 h. p. A 650-h. p. gas engine is a



LARGE TRAVERSING-SPINDLE MACHINE, WESTINGHOUSE MACHINE COMPANY'S SHOPS.

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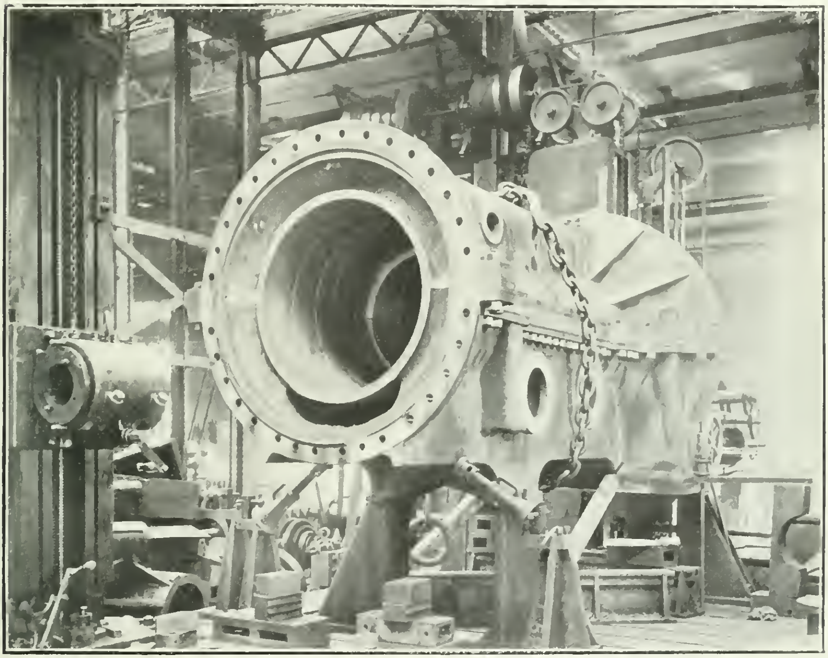
* THE ENGINEERING MAGAZINE has now under engagement a series of articles on advanced foundry practice, by Mr. E. E. Hanna, which in text and illustrations will give a full and most valuable review of the best methods of the more progressive works.

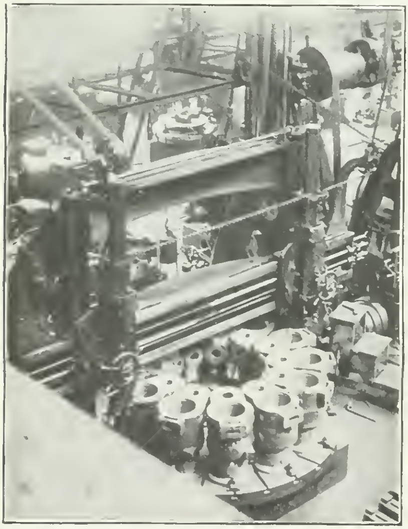
standard production of the establishment. Considering merely the mechanical possibilities of adapting special tools to standard parts, one would expect to find in this shop great use made of the milling machine and of special machine tools, designed and built exclusively to suit the peculiarities of the constructions. The use of milling machines, however, appeared to have increased very little over that which prevailed in these works four or five years since. Two or three large machines of this character are employed in slabbing the peculiar form of connecting rods used in the single-acting steam engines and the three-cylinder gas engines, but almost all of the flat surfaces are finished on planers of the ordinary type, although the vertical boring mill having a horizontal table is very much used for flat second cuts on parts which naturally have one flat cut made in the latter. The planers are in large sizes, and one just completed and running at the maker's shop, takes 10 ft. high x 14 ft. wide through the uprights and under the cross rail. This enormous tool is comparatively short, having, I think, a table travel of about 35 feet only. The table of one of the heavy boring mills shown in the illustration on the next page is filled with a circle of cylinders which have their upper ends faced (the lower ends



THE OUTER SHELL OR CASING OF A 1500–H. P. PARSONS STEAM TURBINE.

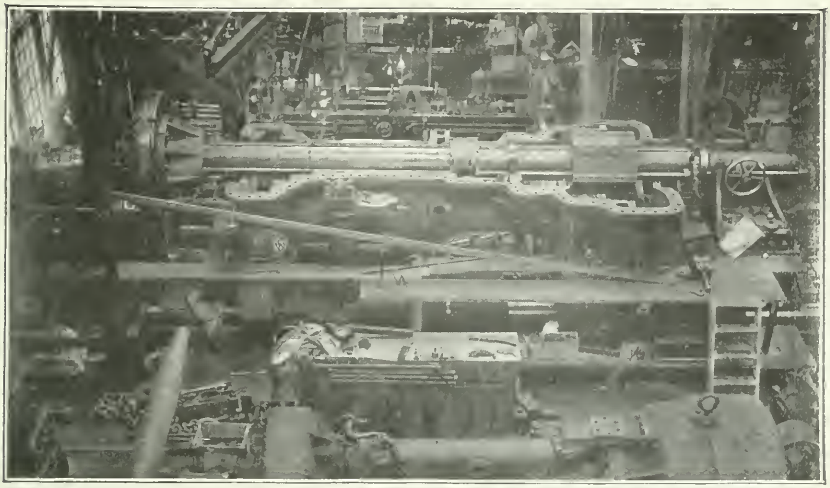
having been finished in the cylinder-boring machine), by a tool carried on a facing arm on the boring bar. The use of the boring mill in this manner, as a sort of rotary planer, is rapidly extending in American practice, and is highly economical in several directions, the finishing being effected much more rapidly than by the planer, or by the use of the boring-bar arm slide. The vertical boring mill is distinctively an American tool, and is vastly more convenient and rapid in action than the large-swing face-plate lathe, to which heavy European shops still cling so devotedly. America is, in fact, the only country which has made extensive use of the boring mill, especially in the way of surfacing a large number of comparatively small pieces at one setting.

At the time when I visited the shops the shell of a 1,500-h. p. steam turbine was in the boring lathe, and next in front of this huge structure was a three-throw crank-shaft for a 650-h. p. gas engine, also in the lathe. The construction of these heavy pieces has given rise to some of the most interesting and most characteristic special tools and special appliances in the shops, the merits of which are fully apparent only after consideration of the peculiar and exacting requirements to be met. In the case of an ordinary steam engine or internal combustion motor the part receiving the impulse of the steam or gases commonly takes the form of a piston, sliding in close contact with the walls of a cylinder in which it travels back and forth. In the case of water wheels and the steam turbine, vanes are substituted for pistons, these vanes having a radial movement instead of the axial sliding movement of the piston in the cylinder. The vane action is almost precisely the same in form and operation as that of the curved paper wings of the toy known as a "pin wheel," in which the wind or a current of air produced by moving the toy rapidly, causes the paper spiral wheel to turn. In the case of



HEAVY BORING MILLS, WESTINGHOUSE MACHINE COMPANY'S SHOPS.

The horizontal table of the large mill is filled with cylinders, arranged in a circle. The lower ends of the cylinders have been faced in the cylinder-boring machine; the upper ends are very rapidly and cheaply finished in the boring mill, as shown.

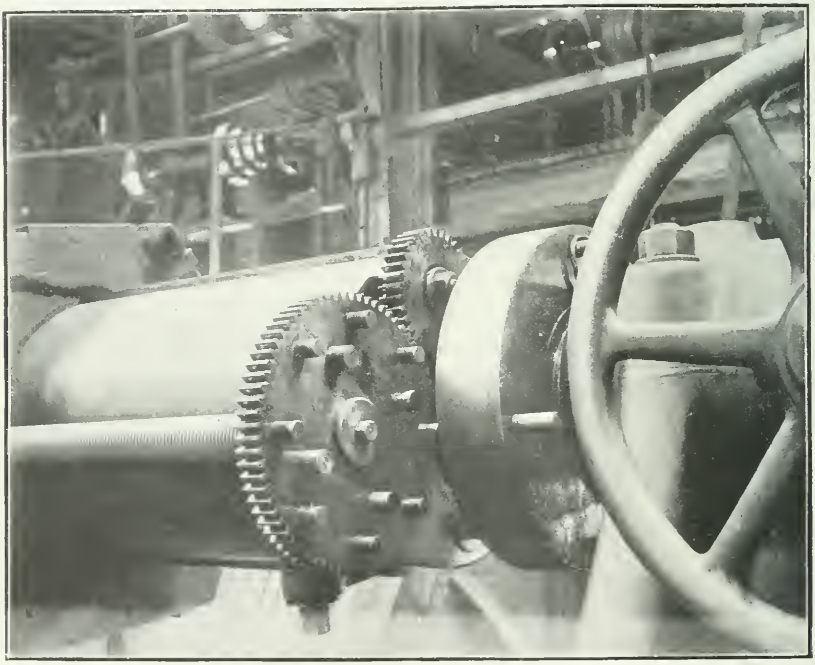


BORING BAR IN PLACE IN LOWER PART OF THE TURBINE SHELL, WITH THE CAP REMOVED.

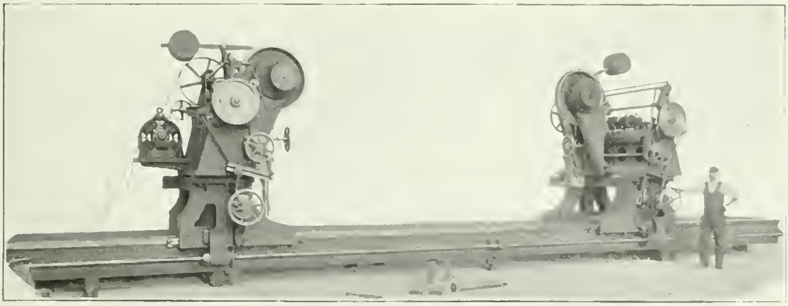
the water turbine, the vanes have considerable clearance in the water-confining and directing case which surrounds them. In the steam turbine, however, this surrounding-case clearance is lowered to the smallest practicable limit, and where the steam turbine is produced in such large units as 2,500 h. p., as it is in these shops, there is a wide field for the application of the tool-maker's art in the construction of the enormous boring bar which finishes the inside of the turbine casing, and in making the thousands of bronze vanes and fixing them to the massive shaft or "spindle" which constitutes the revolving part of a steam turbine.

I regret to say that only meagre details can be given because of pending patents. The illustration on page 733 shows the two halves of the outer casing planed and bolted together, at the large traversing-spindle machine, for rough boring. The interior surface of this casing, when finished, presents a most elaborate assemblage of depressions and elevations, which must be produced with all possible accuracy, and form an extremely difficult construction problem in such a large size. To meet the requirements of this inside finishing a special boring bar was constructed, the rough forging for which weighed 16,000 lbs. This bar has a 6-in. hole chucked through it from end to end, and is provided with a number of sliding heads and collars, and also has a hexagon section of six plane faces, to which "wings," or angle plates carrying wedge-actuated banks of grooving tools, are secured. The final accurate finishing of the bore of this enormous casing was done with the aid of this bar in the lathe, the process being first to adjust tools for cutting the grooves, in the lower half of the casing, so that every cut could be exactly measured, and then to withdraw the tools seated in the boring bar "wings," to bolt the cap in place, and finish the grooves by manipulating the grooving-tool wedges from the outer end of the bar.

There is only one special tool of home construction in the Westinghouse Machine Company's plant, so far as I saw, and that is a small and novel balancing machine in which the work is not revolved to test its balance. With this exception, all the machine tools in use are the regular productions of well-known makers. The small parts are finished on the Hartness flat-turret lathe and on the Gisholt turret lathe, a considerable number of these machines being employed. Great use is made of the traversing-spindle milling, drilling, and boring machines in different sizes. For finishing crank-shafts, the ordinary methods are followed, the only unusual tool being a large vertical planer, or slotter with a worm-driven ram, which carries two slotting tools for slotting up both sides of the crank-wrist cut in a crank-forging blank at once. When these side cuts are made the side-cleared "throat



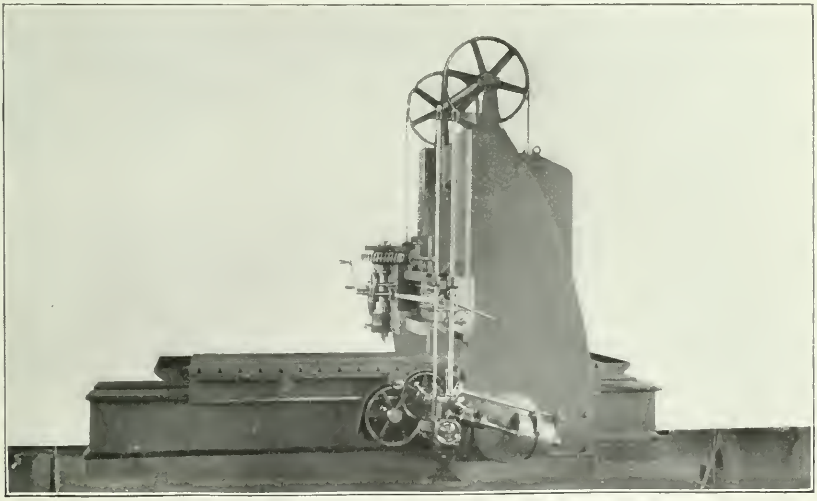
ACTUATING PARTS OF THE LARGE BORING BAR USED IN FINISHING THE PARSONS TURBINE SHELL.



DOUBLE SLOTTING MACHINE FOR LOCOMOTIVE SIDE FRAMES.
Stroke adjustable up to 22 in. Bed 42-ft. long. Travel of heads on bed to suit frames 32-ft. long. Driven by electric motors. Wm. Sellers & Co., Inc.

block" is removed by drilling across in a single-spindle vertical driller, and the shaft is then finished in the lathe, in the ordinary manner.

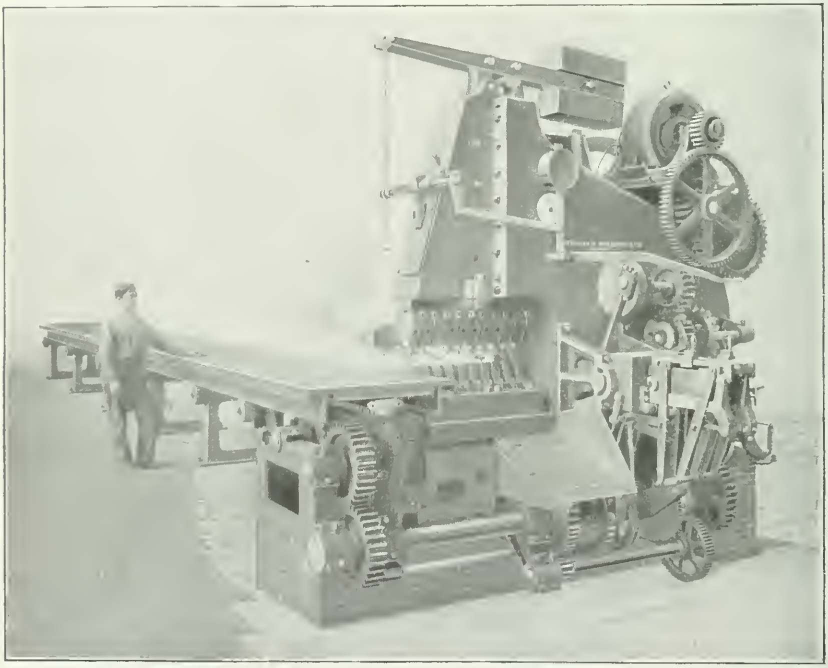
A very accurate system of obtaining and recording all of the essential sizes of every important piece made in these shops has been devised and installed by Mr. Thomas. This system involves new applications of the micrometer to large-size measurements, and such specially prepared book forms of record as enable the exact duplication of any piece ever sent out which is at all likely to require replacing.



TRAVERSING MACHINE FOR SPECIAL WORK ON ENGINE BEDS
48-in x 48-in. x 12 ft. Built by Pratt and Whitney for the Straight Line Engine Company, from designs of John E. Sweet. The peculiar feature of the machine is a perfectly guided cross rail, counterbalanced and with power up-and-down feed. It thus becomes a boring and drilling machine as well as traversing in four directions. The joints of steam-chest covers are finished perfectly, requiring no scraping, grinding, paint, nor packing.

The Westinghouse steam engines, of the single-acting self-contained type, both simple and compound, are repetition productions of large dimensions, just as the air brake is a repetition production of much smaller dimensions. The gas engines are made in all sizes up to 1,500 h. p., and the tool-making employed in producing these engines is of great interest, as it exhibits the most advanced tool-making practice within my knowledge in piston and cylinder-motor construction.

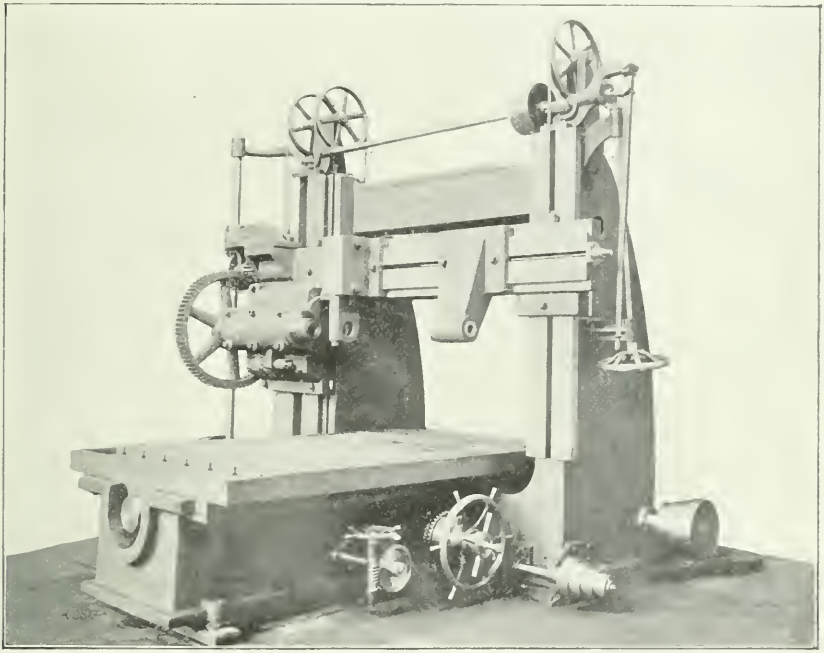
There is, however, apparently little in the practice of the Westinghouse Machine Company to support the contention enunciated in the opening paper of this series, to the effect that the advanced machine shop will not make a very large use of thoroughly skilled mechanics in the creation of its commercial product. While the tool-maker, in his narrower field of deviser and constructor of improved means and appliances for removing metal from parts which require finishing, as well as in that wider field which embraces methods and sequences without touching on machine-tool details, is everywhere most prominently visible, by far the larger proportion of the workmen are skilled gen-



MULTIPLE PUNCHING MACHINE WITH AUTOMATIC SPACING TABLE.

The spacing table, 42-in. wide, is carried in roller bearings and will space automatically up to 8 in. by increments of 1-16-in. Wm. Sellers & Co., Inc.

eral machinists, not 10 per cent. of the whole number falling into the class of specialized laborers. In the air-brake shops, however, as already stated, the conditions are entirely different. The broad differentiation between the two establishments is this: the machine works are operated wholly with skilled labor and without special tools, while the other shop is operated almost entirely with "specialized laborers," and especially constructed and adapted machine tools. In both shops the work produced is of the highest excellence, and in both shops the hour cost of production is very low.

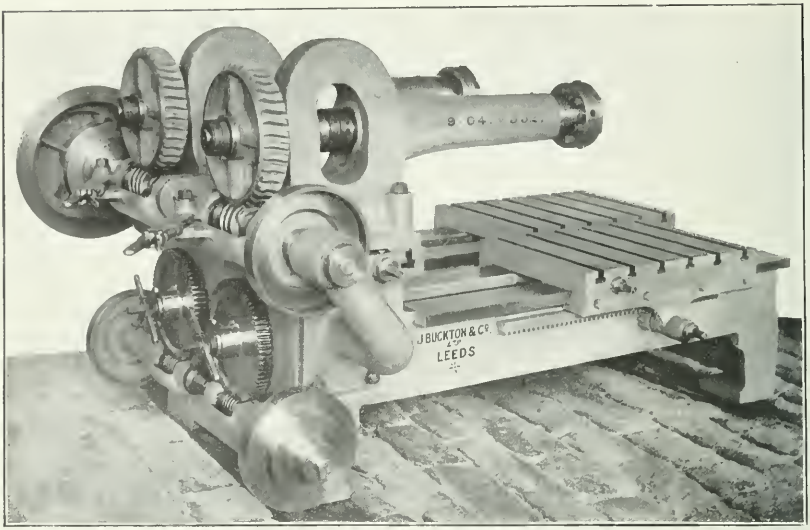


ONE OF THE LARGEST MILLING MACHINES MADE IN THE UNITED STATES.

Admits work 6 ft. wide by 5 ft. high, to mill 10 ft. long. Weighs about 72,000 lbs. Newton Machine Tool Works.

Why then should there be such a radical difference between the two in the machine-tool equipment and the class of labor employed?

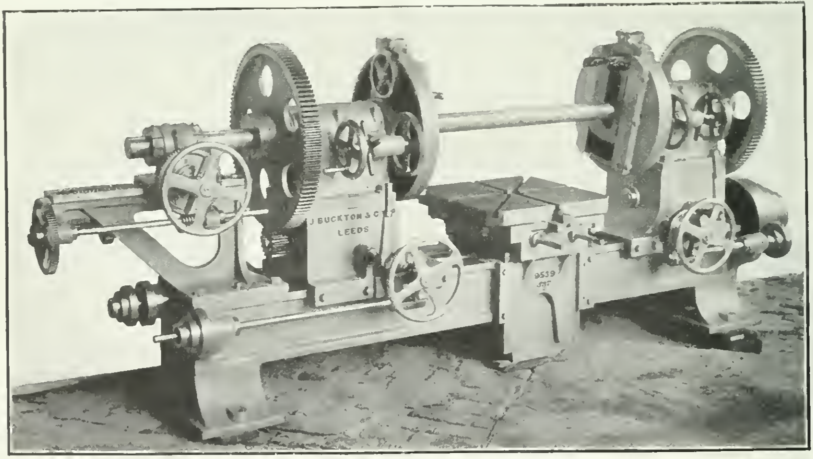
Manifestly there is a size limit—perhaps it would be correct to say a diameter limit—up to which the specialized laborer and the special tool can readily go, and beyond which the general machine-shop equipment and the skilled general machinist must still be employed. With sizes under this limit the whole round of manufacture can fall into routine procedure, without the exercise of discretion on the part of the operative. Beyond this limited maximum diameter various



DUPLEX BORING MACHINE FOR LOCOMOTIVE CYLINDERS.
Adapted for inside cylinders of locomotives, and for other double-cylinder engines. Spindles adjustable and independent, tables operated independently or together. The manner of supporting the heads renders any outboard bearing unnecessary. J. Buckton & Co., Leeds.

exigencies of construction begin to demand the exercise of independent and discretionary powers by the workman.

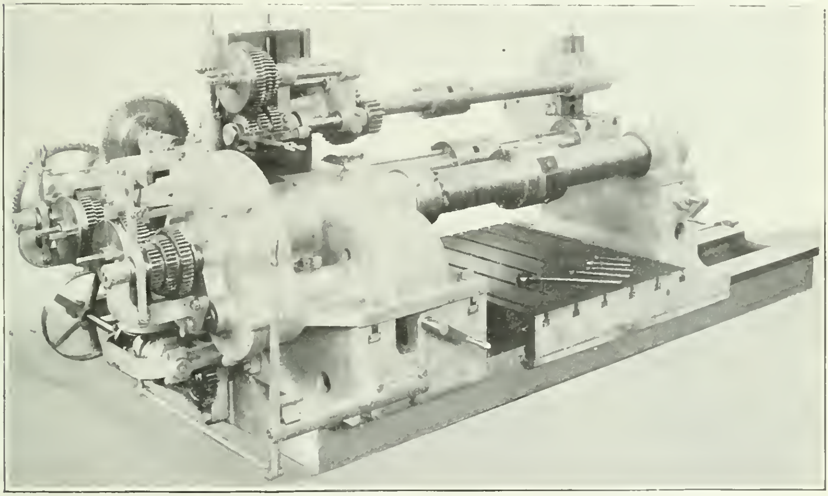
Again, up to a certain diameter limit special tools of not unwieldly or unduly flexible proportions may be employed, while above this limit



DUPLEX FACING AND BORING MACHINE.
For facing two ends and boring cylinders simultaneously. Transverse, vertical, and rotary movements to table, enabling four flanges to be finished at one setting. Boring bar can be withdrawn through headstock. J. Buckton & Co., Leeds.

the first cost, the floor-room, and the up-keep of the highly specialized machine tool, together with the limited demand which is inseparable from larger constructions, overbalance all possible savings of labor-hour cost to be gained by the use of large and highly elaborated special tools. What this ultimate diameter limit is, is as yet unknown. The air-brake work considerably exceeds 12 in. in diameter, and it seems possible that work up to 16 or 18 in. diameter might be automatically produced in the machine shop if the demand for the product could be made large enough to justify the enormous expense of equipment.

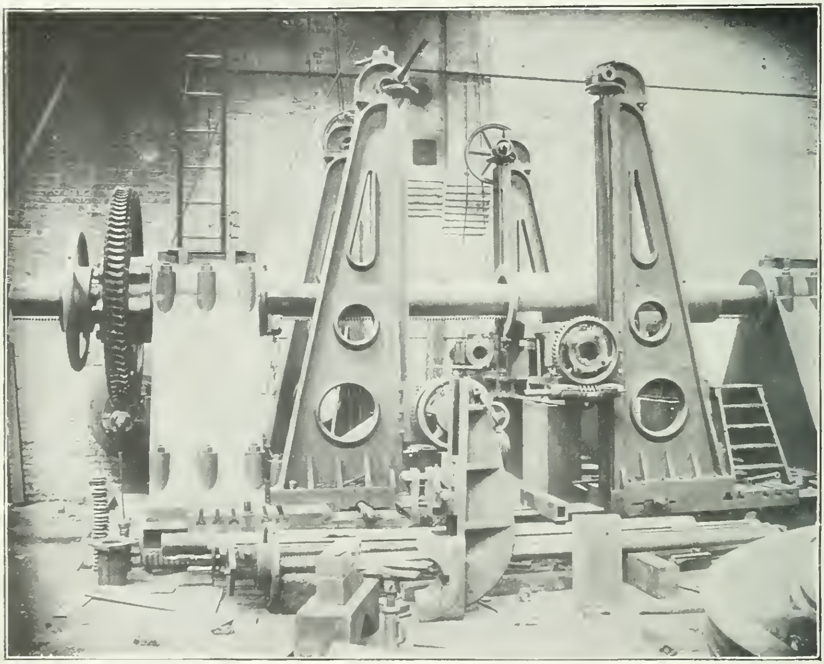
A review of other American shops where heavy work is done suggests that instances exceeding these upper limits are exceptional. At the Pond Shops, Plainfield, N. J., the only tool which I remember as possibly to be classed in the "special" list, is a large face milling machine, or "rotary planer," spindle horizontal, and machines of this form, though not very common, are perfectly well known.



TRIPLE BORING MACHINE FOR CYLINDERS OF VAUCLAIN COMPOUND LOCOMOTIVES. BALDWIN LOCOMOTIVE WORKS.

The work is carried upon a table, and the cutter heads travel along their bars, which are proportioned to suit the diameter of the various cylinders. Two bars are adjustable, so as to cover almost every position in which the three cylinders can be arranged. Wm. Sellers & Co., Inc.

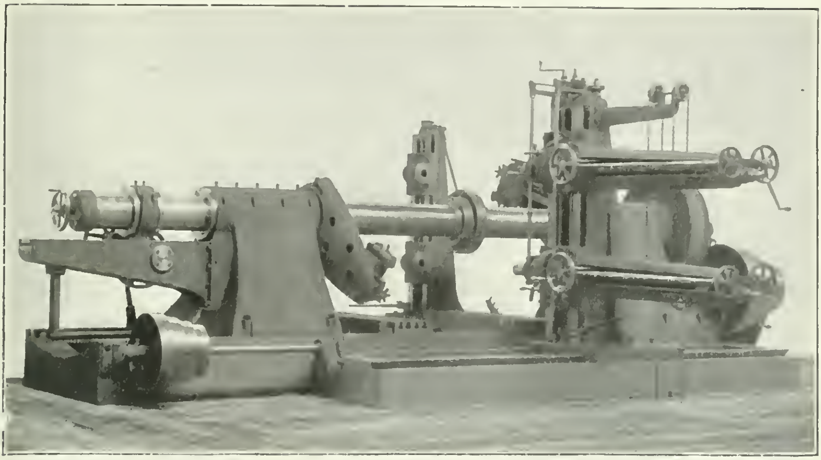
At the Baldwin Locomotive Works, Philadelphia, where the most advanced types of heavy tools have been always in favor, there is a tool of this rotary planer type, by Sellers, used in finishing driving boxes. The Baldwin shops also have some vertical-spindle tools in the general form of upright drillers, which are used to grind the cylinder heads and flanges together. Another special tool at the Baldwin shops is Vauclain's taper-bolt body milling machine; this machine has a number of vertical spindles, each carrying a long hollow mill at its lower end, the hollow mill being made with one flat cutter the length of the bolt body to be produced, and two back-rest surfaces, and the work being wholly submerged in a tank of oil while in process of finishing. The standard taper of locomotive bolts is, I think, ⅛ in. to the foot, and but few taper-body locomotive bolts exceed 10 ins. of body length. This submerged broad-cut milling tool is extremely rapid in action, and produces work regarded as wholly satisfactory.



CORLISS-CYLINDER-BORING MACHINE.
Used and built by Fraser and Chalmers.

There are some very early types of milling machines, "special" at the time they were made, in the Baldwin shops. The Baldwin cylinder-boring machines are worm and worm-gear driven, and are compact, simple, convenient, and effective tools. For boring the Vauclain compound-locomotive cylinders, a special boring machine is used, having three horizontal parallel spindles, built by Sellers. The Baldwin also has one or more special frame-planing machines, by Sellers, which are extremely rapid in action.

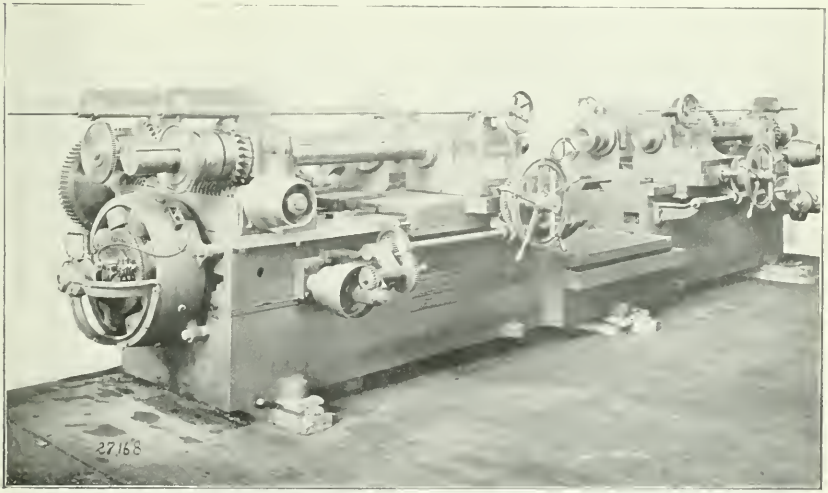
At the Allis shops, Milwaukee, there has been developed a Corliss



CORLISS-CYLINDER-BORING MACHINE WITH TWO CROSS SPINDLES AND FACING HEADS.

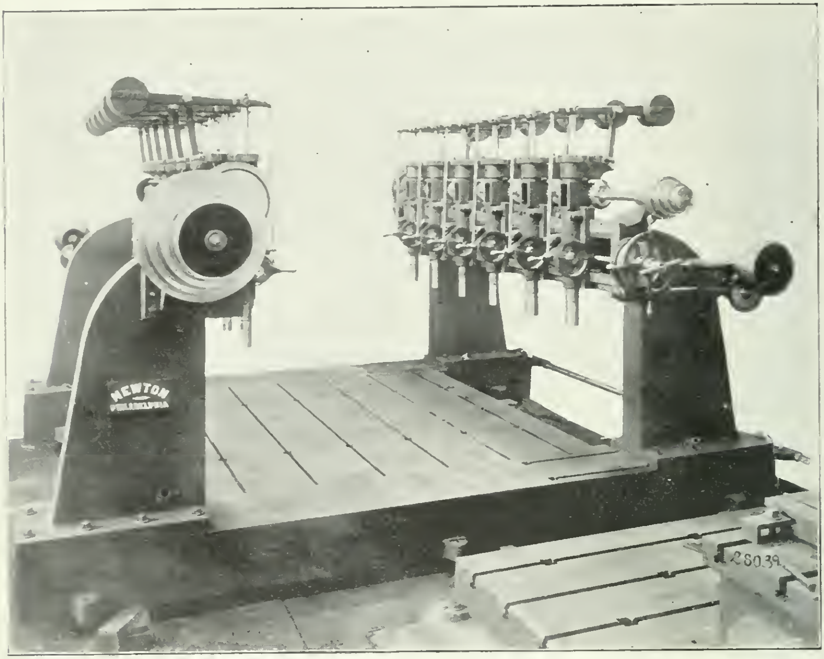
Takes cylinders up to 42 in. diameter and 10 ft. long. The valve seats, at right angles to the axis of the cylinder, can be bored while the cylinder boring is in progress, and with absolute precision. Niles Tool Works.

cylinder-boring machine having cross boring spindles at right angles to the cylinder-boring bar, so that the valve seats, at right angles to the cylinder bore, can be bored while the cylinder boring is in progress. The first tool of this description, a small affair, was, I think, built at the



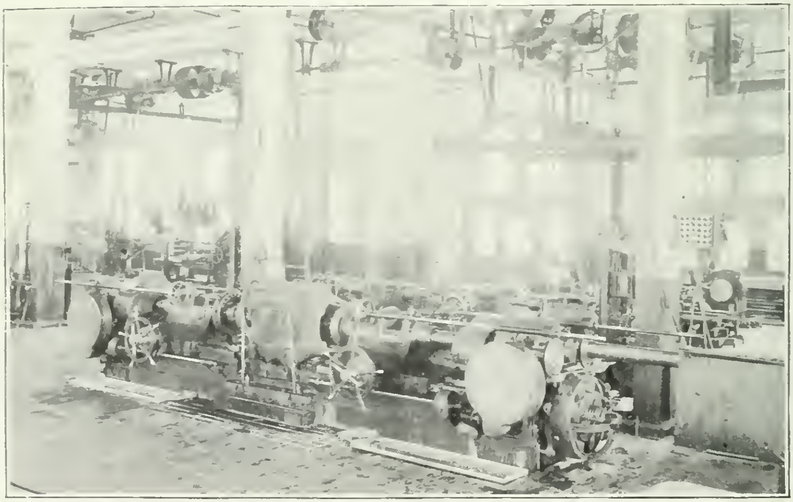
4-SPINDLE BORING MACHINE FOR STREET-RAILWAY MOTOR FRAMES

Used by the General Electric Company, Schenectady, N. Y. The first machine had an electric motor clamped in position. The reconstructed machine, shown above, has a direct-coupled electric drive. Newton Machine Tool Works



12-SPINDLE DRILLING MACHINE FOR REPETITIVE WORK.

The machine is used for drilling the truck frames of a standard pattern of railway car. Newton Machine Tool Works.



BORING MILL FOR ELECTRIC RAILWAY MOTORS.

In the General Electric Company's Shops. Driven by 10-h.p. 250-volt electric motor.

Allis shops, and the design was, I believe, by Reynolds. The Watts-Campbell shops, Newark, N. J., have a fine Corliss cylinder-boring machine, with two cross spindles, designed and built on the premises. Although the Niles shops and Bement drive the bars of their cylinder-boring machines with worm gearing, the large bronze worm gear which was first used to drive the cylinder-boring bar of the Watts-Campbell Corliss cylinder-finishing machine wore out so rapidly that a spur-gear drive was substituted. The Watts-Campbell shops also make use of movable-bracket carried slabbing mills, vertical spindles. applied in a very ingenious manner to Corliss cylinder-finishing. The Waterman Company, now out of business, built one or more Corliss cylinder-boring machines after the Reynolds plans for the Allis Company, and the Niles Tool Works built a very large machine, having two cross-spindles in traversing housings to Reynolds' specification for the Allis Company, and made it a regular product. The De La Vergne Company, Port Morris, N. Y., has one of these large Niles Corliss cylinder-boring machines with two cross spindles, of the type shown in the engraving on page 743.

The Fraser & Chalmers Company, Chicago, also have a very large Corliss cylinder-boring machine of their own construction, which has cross spindles for boring the valve seats of Corliss cylinders simultaneously with the boring of the cylinder itself.

The traversing-spindle milling, drilling, and boring machine is a universal tool which has come into general use in heavy shops in the last twenty or twenty-five years. Prototypes of this tool in small sizes are still in use. One of these early examples is to be found in the shops of the Providence Steam-Engine Company, Providence, R. I. The date of building of this tool, which has a vertically adjustable horizontal spindle on a stationary vertical bracket, and is served by a travelling table to which the work is secured, has passed into oblivion, but the tool is thought to be over half-a-century old: it is still in excellent condition, and is in daily use.

I think the first large traversing-spindle drilling, boring, and milling machines were of British construction, but this type of tool in heavy sizes was produced as much as twenty-five years ago by American makers, and is now marvelously convenient and rapid in adjustment.

The General Electric Company, Schenectady, use a special four-spindle tool, by Newton, for finishing the frames of street-car electric motors, which is very effective, and is also a very beautiful example of special-tool design. The General Electric Company also has in use independently-movable electrically-driven slotting slide pillars, which can be placed in any desired position on a very large T-slotted sole plate. The method of using this combination is to bolt the large work, requiring finishing in limited areas, to the sole plate, and then shift the slotting slide pillars to suit the work to be done, and bolt them in operative position, thus making a universal tool, applicable to finishing a great variety of surfaces otherwise extremely difficult to bring under the action of power-driven cutters. The same general idea runs through both the traversing-spindle machines and the independent slotting pillar machines. There is, in both cases, a large T-slotted sole plate to which the work is secured, and the cutting tools, carried on a movable pillar provided with means for actuating the cutting tools, are then brought into the needful position to effect the desired operations, thus, broadly speaking, bringing the tools to the work they are to finish, instead of, as with the common forms of lathe, boring machine, slotter and driller, and planing machine, bringing the work to the tools. This practice is well illustrated by the example shown in the engraving on page 730.

In the Straight Line Engine shops, at Syracuse, N. Y., a special traversing machine, built by the Pratt & Whitney Company from Prof. Sweet's own designs, is used to finish engine beds at one setting. It is possible by its use to end mill five sides of a piece and drill or bore holes in any one of the sides at one setting, and the joints of the steam-chest covers are so perfectly finished as to require no scraping, grinding, paint nor packing of any kind. It is, in fact, a very complete example of the adaptation of the machine tool to repetitive production of pieces of large size, with a minimum of skilled attendance or individual discretion on the part of the attendant.

All of these tools specified, which are the principal additions made in the most modern heavy shop to the earlier lathe, planer, and slotter outfit, are general tools, having very wide ranges of application, and hence do not fall in the "special" class.

As previously mentioned, the "diameter limit" sets the bounds and marks the scope of special-tool making, so far as the most advanced practice of to-day is concerned.

THE DEVELOPMENT OF WIRELESS TELEGRAPHY.

By Patrick B. Delany.

A LITTLE more than three years ago, a young student, twenty-two years of age, came from his books at Bologna University, Italy,* to London, to consult Sir William Preece, at that time engineer-in-chief of the British telegraphs. Young Marconi had an idea. He had studied under Prof. Righi and was familiar with the wonderful discoveries and experiments of Prof. Hertz of Bonn. He had also made some experiments on his own account, but had he remained at home his distance record for wave telegraphy might not have beaten that of the half score of others who have since been trying to establish for themselves a record of fifty yards or so before Marconi was heard of. That scientists of high renown should be content with the comparison of fifty yards against fifty miles, or more, covered by the school boy, is the greatest possible compliment to the lad.

Marconi made no mistake when he wandered into Mr. Preece's office. He may have heard that no inventor with a meritorious idea or machine ever met with a discouraging reception from that far-seeing, scientific, and practical official, himself at the very time carrying on experiments for wireless communication across the Bristol waters on the induction plan. Preece's work in this and all other methods of telegraphy had been of distinguishing character for more than forty years, he having started his career in Faraday's laboratory.

From Marconi's first visit to Mr. Preece's department his invention grew, each succeeding trial stretching the distance, until England had talked with France. Little or nothing has been said or written about the splendid help given to the new plan by the engineering branch of the British post office, but it may be safely assumed that to the practical experience and great skill of the head and staff of that department belongs much of the credit for the rapid development of Marconi's system, and, curiously enough, during the first year of its operation Mr. Preece had to devote much of his time to defence of the scheme and of his countenance of it.

Like most great inventions or improvements in the arts and sciences, wireless telegraphy is the outcome of the labor, not of one man, but of several. Let us see to what extent the way had been marked out for Marconi. He studied Hertz, and Hertz studied Maxwell, who had Michael Faraday's experiments before him showing some sort of relationship between electro-magnetic waves and light. Hertz could not have overlooked Prof. Henry's discovery forty years before, of the effect of an electric spark upon a distant needle, the spark being given off in the attic of his house and the needle being two hundred feet away. He noted also the effect of a flash of lightning several miles distant. Still more important was his elucidation, in 1876, of the theory which Hertz so brilliantly demonstrated in 1889—that electricity of great pressure, tension, or electro-motive force (oscillatory) skimmed along the surface of the wire without penetrating it, and that only electricity of comparatively low pressure entered the mass of metal. In fact, Henry demonstrated this discovery himself most conclusively in his well known gun-barrel experiment. He was at the time advising a friend how to make lightning rods, and proved that a flash of lightning would travel along an ordinary gas pipe as well as over a solid copper rod of the same diameter.

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* Guglielmo Marconi was born near Bologna, Italy, Apr. 25, 1874, of Italian-Irish parentage.

James Clerk Maxwell, in 1873, after nearly ten years' investigation, published his famous mathematical equations establishing the law of identity of light and electro-magnetic propagation through the ether. Prof. Fitzgerald, of Dublin, had already affirmed his belief in the theory. Hertz proved this by actual measurement of the waves. This is the work that made him famous—and deservedly so, for the way he went about it, the masterly treatment of causes and effects, gained for him the unstinted admiration of the scientific world.

By discharging a Leyden jar, or Ruhmkorff coil, through a short piece of wire circled so that its ends came very close together, the spark jumping the gap was reproduced in another metallic ring suspended by a string thirty feet away. The spark jumping the gap in the second ring proved at once the transmission of electro-magnetic waves through space, or, as there is no space, through the ether. The second spark at a distance also enabled him to measure the waves and fix their rate, proving that they might be a fraction of an inch or 1,000 miles in length, and determining their periodicity to be about one hundred millionth of a second, waves of 2.8 meters in length having the velocity of light, or 186,000 miles a second. He demonstrated that the waves could be reflected, deflected, and screened, and determined their nodal point and outline, all within the walls of his thirty-foot laboratory.

Prof. Lodge and others had experimentd with wave transmission before Marconi came on the scene. The waves had been sent through walls and other obstacles, but the idea of using them for long-distance telegraphy, if thought of at all, was not seriously considered. Prof. Lodge says that nothing but "stupidity" prevented it. It was known that the Hertz detector would not work more than fifteen or twenty yards distance, however, and would never do for a receiver of wave signals transmitted from any considerable distance.

Prof. Hughes, the inventor of the microphone, had discovered that a high-tension spark affected certain forms of his instrument at a distance, and claims to have been quietly planning a wireless telegraph for years before Marconi was heard of. Onesti, an Italian professor, had experimented with copper filings as a variable conductor, but it remained for Prof. Branly, of the Catholic University of Paris, to produce the "coherer," a working receiver for electro-magnetic waves transmitted through the ether. During a series of experiments conducted early in 1891 Branly showed the susceptibility of various metallic powders or filings to the Hertz waves, and an enormous increase in their conductivity when brought within the influence of such waves. Furthermore, he showed that it was necessary only to shake the filings up to restore them to their normal state of low conductivity. The electric wave packed them together, or made them cohere, while a shaking up caused them to decohere. In this simple little device, not larger than two inches of lead pencil, coupled with the Hertz oscillator, Marconi saw his wireless telegraph, and proved the truth of Prof. Lodge's rueful remark that "nothing but stupidity" had delayed the wonderful achievement. Still, it should be remembered that the "oscillator" (transmitter) of Hertz and the "coherer" (receiver) of Branly had been tried before Marconi took them in hand; but, while certain manifestations of their action had been obtained, nothing in the nature of telegraphy was done, and about fifty yards was the limit of the effects.

It should be pointed out here, however, that Prof. Dolbear, of Tufts College, Massachusetts, exhibited at the electrical exhibition, Philadelphia, 1884, an arrangement for wireless signalling which had operated over similar distances. This was several years before Hertz or Branly, but his method was not the same. He used an induction coil as a generator and a telephone as a receiver. By connecting one terminal of the secondary of the induction coil to earth, and the other to one side of a condenser the other terminal of which had points for "discharging into the air," a telephone transmitter or Morse key, operated in the primary circuit of the induction coil with a powerful battery, produced audible sounds in a telephone receiver one hundred feet away. One terminal of the telephone was connected to earth, the other through a battery to condensers arranged as at the transmitting end. Dolbear's idea was apparently not the transmission of electromagnetic waves through the ether, but the electrification of the two "ground" wires and the changing their potential from positive to negative whenever a signal was sent. Regardless of the possible limitations of this method for practical use, it was an original conception of the highest order of genius, and in one feature furnished in advance the main requisite for long-distance signalling—*the vertical wire*, for, without this, it would even now be impossible to telegraph half a mile with the Marconi system.

As Marconi himself made numerous unsuccessful attempts before adopting the perpendicular conductor for the emission of the waves, it is but fair to infer that he had not known of what Dolbear had done. Indeed, according to an account by Prof. Slaby, of Charlottenburg, he and others had been assisting Marconi in trying to establish communication between two points in England, and had spent nearly the whole day without success, when Marconi picked up his receiving apparatus from where they had been vainly striving at the top of a high bluff, and carried them down to the water level, leaving the wire at the top and connecting the apparatus to its lower end. Immediately the signals began to arrive, and perfect working was established with the station some miles away. Marconi was no more likely to have known of Dolbear's kite wire than others, none of whom had tried it.

Even with these three fundamental features, the oscillator, coherer, and vertical wire, there were still serious difficulties to be overcome. The coherer as a "detector" was by no means a telegraph instrument. Marconi, by shunting it with a local circuit in which were connected a local battery, a recorder, and a "tapper" to shake the coherer filings apart after each signal impulse, made the coherer perform the work of the ordinary telegraph relay in general use. These arrangements may be said to be details, accomplished by the use of accessories of ordinary experimentation, but they are of prime importance nevertheless. Marconi's combination of features which had been used only to prove a theory with apparatus that had long been in commercial use shows that he started out with a comprehensive grasp of the importance of his undertaking and a determination not to be balked by the failures of others, or by their belittling criticisms, which were plentiful at the beginning of his work. As Sir William Preece put it in defending him, "they all knew the egg, but Marconi had shown them how to make it stand on end."

The arrangement of apparatus comprised in the Marconi system has been shown and described so generally it is hardly necessary to use diagrams in this article. It consists, briefly, of an induction coil, in the primary circuit of which is a Morse key and about fifty cells of dry battery. One terminal of the secondary coil is connected to earth, the other terminal to a vertical wire carried upwards as far as practicable—say, one hundred and fifty feet.

The terminals of the secondary coil, from which the earth and vertical wires lead, are also connected each to a brass rod having a round knob at the end; these knobs form the oscillator.

At the receiving station there is also a vertical wire. It is connected to one terminal of the coherer, the other terminal of which is, preferably, connected to earth. The coherer is a glass tube, two inches long and of goose-quill diameter. The center of the tube, for about one-eighth of an inch, is filled with metal filings; almost any kind will answer. The terminal wires are led into contact with these filings, which form the connecting link between them. The air is (preferably) exhausted from the glass tube. At the points where the vertical wire and the earth wire enter the coherer tube the wires of the local circuit are joined, and, as already stated, the recorder and tapper with a cell or two of dry battery are included in this local circuit. This is the operation: When the key of the sending station is pressed down, the primary circuit is charged directly, and the secondary circuit inductively. The automatic or mechanical interrupter of the primary causes interruptions in the secondary at the same time. These induced currents jump across the gap between the two brass knobs, charging the vertical wire with oscillatory electricity of great electro-motive force. This electricity spreads out from the wire like the waves caused by the splash of a stone in smooth water. These electric waves are vibrated through the ether at the rate of about two million a second and with the velocity of light.

They compass the vertical wire at the receiving station, pass through the filings in the glass tube to earth, and in doing so cause these filings to lie closer together and cohere. This makes them a good conductor for the local circuit in which the recorder and tapper are placed, and permits the cell or two of battery to work these instruments. When the lever or the tapper comes down it jars the filings apart, or decoheres them, making them a bad conductor again, practically breaking the circuit of the recorder and tapper, which in itself is nothing but an ordinary telegraph sounder. The coherer is now again in a receptive disposition for the next signal. Various modifications of this arrangement have been suggested and patented by

Marconi and others, such as using an induction coil at the receiving station also, and placing the coherer in the secondary circuit, with or without condensers, so that the filings will be affected by the induced current produced by the passage of the original current through the primary coil, etc.; but these are not of importance here.

Certain drawbacks relating to transmission and reception of actual Morse dots and dashes limit the rate of working to about twelve words per minute, or about half the speed of a good wire circuit. So far as I know, the main trouble lies in the slow rate at which the primary circuit of the induction coil at the transmitting station is made and broken by the automatic interrupter, said to be eight or nine times per second. Now, as it is possible for a Morse operator to work his sending key sixteen times or more per second, he must, with the present rate of vibration, work the key at a rate considerably less than eight per second, as otherwise the waves would not be sufficiently continuous to deliver the dots and dashes to the receiver. When the key is pressed down for a dot it must not strike in between the makes and breaks of the vibrator, and when held down for a dash it must be for sufficient time to insure a full sized one. Thus all the characters, dots and dashes, are made up of fine dots. The ink recorder must be so adjusted that its marking point will not respond to the fine dots, but only to the characters formed by the sending key, which are made up of short and long showers of short pulsations. The tapper, however, to be effective in shaking the coherer, must be adjusted so as to respond to every short impulse, otherwise the filings would not be ready for the next succeeding wave. It would seem from this that to the limitation of the speed of the tapper lever may be attributed the imposed low rate of automatic interruption of the primary circuit at the transmitting station, and hence of the speed of transmission. The tapper might be made to respond more quickly by increasing the local battery and the tension on its pull-back spring, but strong local currents must not be sent through the coherer, as they would cause more self-induction in that circuit, requiring more counteraction by condenser discharge, etc. An increase in the rate of automatic interruption of the primary circuit would not only permit of greater speed of transmission, but probably would increase the distance of communication, as the more quickly the sparks follow each other in bridging the gap of the oscillator, the greater the power of propagation through space. It is hardly probable that the coherer in its present make-up will abide as the receiver for wireless telegraphy. Some device of more positive action will take its place. One has already been proposed by Prof. Fessenden, of Allegheny.

In view of the previous creation of all the separate parts of Marconi's system (the tapper included), even those most generously disposed towards him find it difficult to form a basis for as much credit as they think he deserves for the results obtained. But, as already stated, it should be remembered that all these separate parts had been in existence for several years before and were well known to veterans in the field of electrical investigation, and yet nothing of any practical value in the way of space telegraphy had been accomplished. Leading scientists had, it is true, been talking about it for half a century by conduction and induction, and by Hertz-waves since their discovery, but none of them seemed to have faith enough in the soundness of the demonstrated theory, or ability to tackle successfully the practical side of it with that pluck and perseverance necessary to carry it through. Surely the inducement was ample for the highest order of genius. The earth-conduction plan and the induction plan had resulted in reaching out four or five miles, using parallel wires of a mileage twice the distance spanned. To communicate fifty miles without parallel or other wires would have crowned the loftiest ambition of the most distinguished. Marconi's sudden bound into fame is the proof. He joined up the elements of success in a masterly way and jostled the savants out of his road.

There is one peculiar circumstance in connection with Marconi's work which other experimenters are just beginning to notice. It is, that, notwithstanding the fact that hundreds of them connected with war, navy, and the telegraph departments in their respective countries, as well as scores of others working in their individual capacities, all have full specifications of Marconi's patents before them, as well as published particulars of his arrangements for working, in no single instance have results been obtained approximating those secured by Marconi himself. The wide discrepancy can hardly be attributable to superior expertness in adjusting apparatus, or arrangement of details. There must be something more, and, as the coherer is the only part of the system susceptible of unlimited change without outward manifestation, it may be that Marconi is in no hurry to disclose *all* that he knows of the subject, knowing, as he does, that all the world is now his competitor.

While electro-magnetic waves have been sent three hundred feet into a coal mine, made to penetrate stone walls, and warp over hills, they experience obstruction and distortion in all these things.

The farther away from the earth, the better they go, some say, because the high strata are better conductors. Maybe it is owing to removal from obstruction, and it is not improbable that the electrostatic capacity of the earth itself may play a part. Experience shows one hundred and fifty feet of vertical wire to be necessary for sea distances of fifty miles. From balloons a mile or so up, and with powerful waves, it might be possible to telegraph across the Atlantic. The sea is undoubtedly the field, so to speak, for the new system. Communication between ships, warning them away from dangerous coasts, covering areas with appeals for help in distress, directing and controlling torpedo boats, as designed by Mr. Tesla, controlling balloons—in fact, almost any work possible by a wire, and much that is not may be done by the wireless system, provided it is kept away from the earth's topography, and the things covering it. One of the shortcomings yet to be overcome—and it is not easy—is the "town crier" character of the new transmission. It can, to some extent, be shut off from one section and projected over another, like the searchlight or the sounds from a megaphone; but the outer edge of a long sector covers many miles. Synchronism, resonance, etc., have been proposed, but up to this time the system in its simplest application would not admit of any added complication. Until some plan of selection is found, the scope will be comparatively narrow.

Messages may be received by any number of coherers. And there is no means of discovering that the etherial line is being tapped; or, an oscillator turned on anywhere in the vicinity of an operating plant will thwart its usefulness. It may be that telegraphy will not be the most important use for electric waves. A few years may develop applications not now thought of. No wider way has ever been opened for scientific observation of the relation of electricity to physical existence.

The first flash of lightning to find within range of its magnetic wave a few particles of metallic dust in the bosom of some caverned rock or mountain peak put into operation the fundamental principles of wireless telegraphy. Under the influence of the lightning bolt, the metallic particles were compacted together, making them a better conductor. The thunder's rumble immediately following shook them apart, making them a poor conductor. The clouds constituted the oscillator, the flash the transmitting wave, the metallic dust the coherer and the thunder jar the tapper. It would, indeed, seem that in Nature's laboratory all things are in operation, and that man needs but draw the curtain to disclose them.

EDITORIAL COMMENT

Reviewers of the Spanish-American war have again and again pointed out that Spain had all the advantages of equipment which modern invention affords. She had the best ships and armament money could buy. Yet southern mechanical ineptitude produced an apparent disparity which was absolutely pitiful, as it was shown in the naval battles of the summer of 1898.

The war in Africa, on the other hand, is a sombre display of the effect of military mechanics when the opposing sides are more nearly equal in skill in handling war machinery. The Boers are not a mechanical people, but the "vigour of the northern brain" is there, and race characteristics show themselves in ability to handle the engines and appliances of battle, though they did not build them.

* * *

Col. Prout sides with some other railway experts, and with other authorities familiar with Africa's conditions if not with transportation matters, in his doubts of the economic advantages of the Cape-to-Cairo line.

But the best of these critics will be readiest to admit that undertakings so broad in character as this have repeatedly triumphed over all doubt and confuted the most careful calculators of their future. So it was with the Suez Canal; so, to take a case more nearly in point, has it proved with the transcontinental lines of America, against which were brought the very same arguments based upon the vast stretches of unproductive and non-traffic-supporting country to be crossed. It has become a truism that "facilities create traffic"; the "dream of the visionary" has more than occasionally caught the truth which the statistician could not see.

It needs, perhaps, a long look ahead to justify any of the huge enterprises for "utilising to the fullest, the material resources of the earth." "Such effects are too wide to be judged by the ordinary financial tests. The return to investors measures but a fraction of the total gain." And beyond all this is the politico-economical influence of the great central bond, linking together the whole of the new wealth-producing and manufacture-consuming empire of eastern Africa. No system of disconnected spur lines would serve this development.

* * *

In the opening of the Chicago drainage channel a great engineering work was brought to a successful conclusion in one sense, but it is probable that a still greater engineering problem has only been initiated by the same event. When the sewage of a city of moderate size is turned in a raw condition into a stream, possibly to pollute drinking-water supplies of places below, it is generally done in such a gradual manner that no concerted opposition is made until the evil has grown unsupportable. When, however, the whole drainage of a great city is thrown at once into the waters of a river upon the banks of which many water works are situated, attention is most forcibly drawn to the magnitude of the injury.

The problem thus raised may be one for the lawyer, but it is certainly one for the engineer. It is of vital importance that every city, great or small, should have a full and complete discharge for its sewage; but it is also of vital importance that no water supply should be poisoned by such drainage. Two things are thus to be accomplished, and both of them are fully within the province of the engineer. The sewage can be rendered nearly, or altogether, harmless, and the water can be effectively purified. Purification plants for the sewage, filtration plants for the water works—these must soon be essential parts of every municipality; and every attempt of one city to dump its filth into the water supply of another should hasten the time when such pollution shall be rendered impossible.

* * *

A good illustration of the part which the designing engineer plays in the adaptation of repetitive processes to practical work is found in the case of a recent invention of importance, which although "made in Germany" was imported to the United States for development there. This machine, an internal-combustion motor of international note, had been carefully designed and constructed by one of the leading establishments on the Continent, and both in appearance and performance it apparently left nothing to be desired.

It was soon found, however, that in design it was wholly unsuited for manufacture on a commercial scale according to American methods, and that it was necessary that it be entirely re-designed—not to improve its performance, but to eliminate the large proportion of hand work involved in the original design, to avoid the necessity for a large portion of highly finished parts, and to adapt it in every respect to commercial production in quantity.

Something has been said in other pages of this Magazine about the revolution in machine-shop practice, but it is evident that if the revolution is to be fully completed the men who design the products must be trained to a complete grasp of the methods by which their designs are to be executed.

* * *

The preponderance of the mechanical side of all branches of engineering, about which comment has been made of late, appears to be continually on the increase. The civil engineer now looks to the workshop for metallic portions of bridges, dams, harbour works, and nearly every detail of his work; the architect has been described as a man who "puts architecture" on structures erected for him by mechanical engineers; and even the military engineer must soon become a sort of fighting mechanic if he is to keep pace with the progress of the profession. A notable instance of this preponderance of mechanical engineering is seen in the fact that two of the most important papers recently presented before the Institution of Electrical Engineers dealt wholly with the mechanical problems connected with the generation of power, including the cost of raising steam, the advantages of different kinds of fuel, the most advantageous arrangements of boilers and furnaces, and all the details of the production of mechanical energy for use in electrical work.

REVIEW OF THE BRITISH PRESS

Cheap Fuel and Electrical Energy.

THE question of the cost of fuel forms such an important feature in the operation of electrical generating stations in England, where water power is only available to a limited extent, that the paper of Mr. R. E. Crompton before the Institution of Electrical Engineers is of much interest.

Mr. Crompton classifies the cheap fuel available for generating electrical energy into three groups. The first includes those in which the calorific value is chiefly in the contained carbon, such as anthracite and small Welsh coals and refuse coke-fuels. There are no great difficulties in burning these fuels, as they are cheap because they are friable, and not because of any great proportion of impurities. The second class of cheap fuel is the free-burning small coal of the Midland districts, only slightly bituminous and with but little tendency to cake, and containing earthy impurities. The third class is the small and dirty bituminous coal of the North; difficult to deal with, but possessing a high calorific value.

The principal difficulty with fuels of the first class is that their finely subdivided condition renders it difficult to prevent a large portion from falling through the grate-bars or from being carried forward into the flues in an unconsumed condition. Special furnaces have been designed to obviate these difficulties, but with only partial success. The attempts to deal with the second and third classes of fuels have been chiefly connected with the use of automatic appliances for distributing the fuel over the bars, breaking up and getting rid of the clinker, and providing sufficient admixture of air at various points in the furnace to ensure satisfactory combustion of the gases.

In many cases these results have been attempted to be gained by the use of automatic stokers, and while such devices operate very well in many instances, yet it is often the fact that the economy effected in stoking is offset by the cost of removing clinker, and by the wear and tear on the grates. Automatic stokers have been most successful with the third, or highly bituminous class, the coal being spread on the front end of the grate, where it is permitted to coke, and then gradually moved back and broken up at the point where intense combustion and radiation is required. Here again, however, the automatic mechanism is seldom capable of contending with the excessive clinker which such fuels form, and much hand labour is required to effect its loosening and removal.

Another method, briefly touched upon by Mr. Crompton, is that of gasifying the fuel in gas producers, and subsequently using the gas under steam boilers. Several forms of producers have been designed for this purpose, including devices for preventing the formation of solid clinker and attachments for the utilisation of by-products. While this application is not extensively considered by Mr. Crompton, it evidently has large possibilities, not so much in respect to the furnishing of fuel for use under steam boilers as for use in connection with gas engines. When it is considered that the modern gas engine, even in small sizes, is vastly more efficient than the steam engine, and that gas engines as large as 1,500 h. p. are now accomplished facts, it is evident that the gasification of very low-grade fuels in gas producers for use with gas engines must be considered as one of the very best methods of utilising such fuels. The fact that this method also affords a perfect solution of the smoke problem is not the least recommendation in its favour.

It has been maintained that the combustion of low-grade fuels under steam boilers involves a general increase in the size of the entire plant, because of the lower heating capacity of the fuel, and that a larger capital expenditure is therefore necessary. Mr. Crompton, however, shows that in the case of externally-fired boilers it is only necessary to increase the size of the furnace, the larger grate area, properly arranged, permitting the combustion of a sufficiently greater volume of the low-grade fuel as to provide the same steaming capacity as when high-grade fuel is burned upon a smaller grate.

For the low-grade bituminous fuels a travelling grate, based upon the old design of Juckes, is recommended, a firebrick arch being constructed over that portion where the intense combustion occurs, thus affording a storage reservoir of heat to prevent chilling of the fire. In this way a satisfactory combustion may be secured without the necessity for admitting too great an excess of air, with the consequent evil of retarding the combustion by cooling.

Such an apparatus has been introduced by Mr. Crompton at the new works of his firm at Chelmsford, and from comparative tests made during 49 weeks' operation he gives some interesting data.

Using Nottinghamshire steam hard coal of best quality, costing 17s. 5d. per ton, the cost of fuel was 64 per cent. of the total cost of electrical energy, this cost being 0.77d per Board of Trade Unit (kilowatt-hour), while with the cheap low-grade fuel at 5s. 4d. per ton the total cost per kilowatt-hour is given as 0.43d., of which 35 per cent. is for fuel.

It must be remembered, however, that the advantages gained by cheap fuel are only to be expected within reasonable distance of the collieries where it is to be obtained, the cost of transport rapidly neutralising the economy. Mr. Crompton places the maximum distance from the collieries at which these low-grade fuels can be used as within a radius of 50 miles, but it should be commercially possible to transmit the electrical energy generated within such areas to points much further beyond before the advantages due to fuel economy are lost.

Effects of the Manchester Ship-Canal.

The real value of any great industrial enterprise, such as a railway, a harbour, or a canal, cannot be fully measured by the direct advantage which is gained by the handling and transport of merchandise. Very often these are least of the benefits, and the indirect advantages are nearly always felt before the actual traffic reaches very profitable proportions.

An excellent example of the benefits which accrue to the surrounding country from a great engineering improvement is found in the effects of the Manchester Ship Canal. This subject has been well presented before the Manchester Statistical Society in a paper by Mr. A. Woodroofe Fletcher, and from an abstract in the *Engineer* some of the salient facts are taken.

Prior to the commencement of the canal Manchester was practically in a stationary condition, and, indeed had begun to fall behind. Assessments had fallen off, warehouses were empty, the number of employees in the mills had decreased, and many dwellings were unoccupied.

The beginning of the work upon the canal naturally caused some improvement in the immediate vicinity. A large proportion of the cost of construction expended in wages gave considerable impetus to a number of local trades, while the railways, even before the opening of the canal, made such reductions in their charges as to help many industries which had been affected. After the canal was opened the improvement of affairs which had commenced beforehand, steadily increased, and has continued up to the present time.

The ratable value of the city of Manchester is higher than it has ever been before, notwithstanding the fact that there is no room for more buildings without pulling down the old ones and erecting new ones of greater value. The building of new dwelling houses has been extensive, correspondence has increased nearly 16 per cent. a week, and the increased demand for water, electricity, and gas, has resulted in greatly increased revenues notwithstanding a reduction in rates.

The general saving by the use of the canal itself can only be estimated, but Mr. Fletcher computes that there is a direct annual saving to Manchester of £290,000 by the general reduction in rates, besides a saving of £200,000 a year on the goods which the canal carries itself. Oversea charges have also become less. The rate per ton of 40 ft. from Manchester to Bombay was, in 1892, 23s. 6d.; in 1896 it was 21s.; the rates to the East Mediterranean were reduced by one-third in the same time. Freights to Antwerp, Hamburg, Rotterdam, and other ports have been reduced from 10 to 40 per cent., while in 1896 the North American trade was carried on from Manchester at the same rates as those charged from Liverpool; the Mersey Dock Estate having made reductions in their charges of more than 20 per cent.

So far as the canal itself is concerned, each year has shown a good increase in traffic, and from a table given it appears that from 1,358,875 tons in 1895, it has grown to 2,595,585 in 1898, while data for the first half of 1899 show a proportional increase.

Mr. Fletcher is inclined to put down practically the whole of this revival in trade to the Ship Canal. He thinks that few will hesitate to say that, whatever minor forces may have contributed to the general result, the one cause which far outweighs all others is the opening for traffic of the Ship Canal. The period of depression already referred to was attributed at the time to the keen competition to which Manchester was subjected by reason of the cost of transit of goods compared to that to which other manufacturing centres were put. This cause of depression has been largely removed by the canal. "Surely the quickening of local commerce and the revivifying of local industries, which we now see, are not merely the periodical flowing of the tide of prosperity, to be followed at no distant date by a corresponding ebbing of the tide, but they are the signs of a permanent accession of wealth and material well being."

Mechanical Engineering in China.

In view of the general interest of all European nations in the opening of China to commerce and industry, the address of Lord Charles Beresford before the Institution of Mechanical Engineers upon the subject of openings for mechanical engineers in China is especially timely.

Lord Charles is neither an engineer nor a commercial man, but he is a keen observer, well fitted to see wherein opportunities for success may be made, and his remarks, while subject to discussion, contain much that is suggestive.

Naturally the first subject of attention was the development of railways, and with this is included electric tramways, for the ubiquitous trolley has already invaded the flowery kingdom. Although only 317 miles of railway had been constructed at the time of Lord Charles's visit, there were 2270 miles under construction and 2507 miles projected and partially surveyed. This means that in a few years nearly 6,000 miles of track will have been laid, and although extensive works have already been erected at Tongshan under the able supervision of Mr. C. W. Kinder, there must be ample occupation for engineers in the future development of this work. Skilled native labour is by no means cheap, and foreign supervision is absolutely necessary to insure success to any enterprise.

Electricity has mainly been used for lighting purposes up to the present time, but a tramway has been constructed from the railway station to the gates of Pekin, and others will doubtless follow.

The abundance and cheapness of coal should render the installation of electric plants a profitable and important form of undertaking after a short time. Unless Englishmen are prompt, however, much of the vast electrical plant which China will require will come from Japan and America, and it is more than probable that Japanese and American engineers will reap the benefits and opportunities. American electrical plants are prominent in Japan, and the electrical manufacturing industry is rapidly developing there, and the great start which both countries have over Great Britain in electrical work gives them an advantage which it will require promptness and energy to meet.

China is a country of great mineral wealth: coal, iron, gold, silver, copper, mercury, lead, and salt are all to be found in paying quantities, and only skilled workers and the latest machinery are needed to develop the mineral resources of the country. Russia appreciates the importance of the gold deposits in Manchuria, but there are other sections equally rich. The development of mining means a field for nearly every branch of mechanical engineering; motive power, pumping and other hydraulic machinery, electrical power and transmission, compressed air, and all the resources which control the forces of nature for the use and convenience of man, must be pressed into service.

The development of manufactures in China, while it will make an extensive market for British machinery, will also develop an important competition with British commerce, and of this prospective change Lord Charles has something to say. China will doubtless become a better customer when she has exploited her minerals, and other natural resources, and has more money to spend abroad. Then again an increase of supply increases the demand, and the association which is the result of manufacturing organisation will create a greater demand for articles until now not required. If China becomes an active competitor in some directions she will become a better customer in other lines, so that while individual industries may suffer the general volume of trade will increase. The laws have held good elsewhere, and there is no reason why they should fail in the present case.

One of the greatest defects in such industries as now exist in China is that of imperfect management. The practice is to pay high dividends so long as the business holds out, putting aside nothing for depreciation, and when the inevitable crash comes, it is necessary to lay down a whole new plant. Many of the prominent industries, such as silk and tea, are hampered by old-fashioned methods and appliances, so that much of the silk trade has been taken by Japan, while the tea trade has gone to Ceylon. It seems altogether possible that British companies, established at treaty ports, could buy up large supplies of raw silk and green tea from the Chinese farmers, and, by the use of modern methods, develop extensive and profitable businesses.

Lord Charles emphasises the importance of an acquaintance with the Chinese language, and even goes so far as to recommend the establishment of an engineering school at Hong-Kong, where Chinese could be acquired colloquially at the same time as instruction in engineering, but whatever may be thought of the feasibility of this idea, there is no doubt that the same necessity exists for an ability to speak the language as has been found in other foreign countries where trade has been developed. The main point he emphasises is that English engineers must act promptly and vigorously if they do not wish to see the great opportunities in the Chinese Empire seized by Japan, America, Russia and Germany.

"The potential possibilities of the Chinese Empire are enormous and scarcely to be calculated. To the enterprise, pluck, skill, perseverance and knowledge of mechanics must be looked for assistance in realising the latent resources of that ancient empire, and in keeping the flag of Great Britain ever in the van, no matter in what direction progress is made."

A Mean-Pressure Indicator.

THE term "indicator" as applied to an instrument used in steam engineering has come to be applied almost exclusively to an apparatus for tracing the pressure cycle occurring in a steam cylinder, and all the ordinary forms of the instrument consist essentially of a device which traces a closed curve showing the pressure upon one side of the piston at every point of the stroke. From such a diagram, by measurement and computation, the mean effective pressure may be determined.

Professor William Ripper has devised an indicator of an entirely different sort, although with the same end in view, that is, the determination of the mean effective pressure, and in a recent paper before the Institution of Mechanical Engineers he gives a very complete account of his apparatus.

Instead of giving a diagram of a single cycle upon one side of the piston, Professor Ripper's apparatus records continuously, both the impelling pressure upon one side and the opposing resistance upon the other, and instead of doing this upon a distance-basis it does it upon a time-basis. This result is obtained by the use of two pressure gauges, identical in principle with those used for indicating boiler pressures, these gauges communicating with the steam cylinder through an oscillating or rotating valve so that one gauge is in connection with the cylinder during the out-stroke only, while the other is connected during the return. It is obvious that the gauge which is in communication during the out-stroke receives only the impelling pressures upon the piston, while the other gauge will receive the resisting pressure. Under ordinary circumstances the needles of gauges thus exposed to varying pressures would show a periodical jumping similar to the motion of an indicator piston, but by partially throttling the openings Professor Ripper has succeeded in reducing this action to a slight trembling, the needle practically remaining steady at a point corresponding to the mean pressure. This is especially the case with high-speed engines in which the impulses succeed each other very rapidly, and it is therefore possible with this apparatus to read off at any time from the gauges the mean effective pressure without delay or uncertainty of computation.

As already explained, this apparatus gives the mean effective pressure upon a time-basis, but Professor Ripper shows that there is but a slight difference between this and the pressure taken upon a distance base. Moreover there is practically a constant relation between the two, and for any given engine, a factor can readily be determined by comparison with diagrams from an indicator of the ordinary type, so that the correction can be made at any time.

The principal points to be observed in the construction of this continuous indicator are the reliability of the gauges and the operation of the valve. The latter is a mechanical problem which may be solved in various ways, and in the author's paper details of some of these are given. So far as the gauges are concerned, there is really no reason why these should be any less reliable than indicator springs when equal care is given to their construction. An important feature in connection with the gauges is the necessity of providing effective water-siphon connections, in order that the gauges themselves may be kept cool. With proper precautions, both as to construction and use, there appears to be no reason why the apparatus should not give entirely reliable results.

Of course such a continuous indicator is not intended to supersede the ordinary instrument, but rather to supplement it, especially in long tests and especial researches. It gives only a very general indication of the working of the valve gear, and affords no permanent record from which the action of the steam in the cylinder can be studied. It does, however, enable the continuous working of the engine to be observed in a manner altogether impossible with any series of ordinary diagrams, however extensive, and avoids the necessity of taking and computing many hundreds of cards.

Since the apparatus must practically be built as a permanent part of the engine, it lacks the portability of the ordinary indicator, but in this respect it may, in many cases at least, come to be regarded as a portion of the permanent outfit to the same extent as the ordinary pressure and vacuum gauges.

Machine-Tool Building.

In concluding an interesting series of papers upon British and American machine tools which has been appearing in successive issues of the *Engineer* a summary is made which lays down some wholesome, if not altogether welcome, suggestions as to conduct in the immediate future. These points are best given in the original words of the writer; which have added weight when the standing and opinions of the journal in which they appear are taken into account.

"To sum the matter up, if we are to maintain supremacy in the machine-tool trade in the future, the following points must be borne in mind:

"(1) A more intimate knowledge of what is being done by others is essential. The time for concealing methods of manufacture has gone by, and a constant intercourse between makers is necessary to stimulate ideas, besides greatly increasing the opportunities of economic manufacture.

"(2) The system of specialising and confining one's attention to a limited variety of work is necessary for the perfecting of any class of machine, and for the reduction of cost of manufacture.

"(3) The principles of trades unionism which tend to limit the capabilities of our working man, destroy his individuality and independence, or limit his capacity for production, must be eradicated.

"(4) Our workmen must be prepared to extend their hours of labour to a number per week at least equal to those of other countries.

"(5) Encouragement must be given to our workmen in suggesting improvements, and any legitimate ambition to better their position which they may possess should be cultivated. It is not too much to say that a very large portion of the success achieved by American machinery is due to the efforts of the American working man. Indeed, if the origin of many of the ingenious attachments on their tools be investigated, the larger portion of them will be found to have emanated from the workshop rather than from the drawing office, while a number of principals of the best manufacturing concerns in America at the present day have risen from among the ranks of this class."

While the force of these remarks must be admitted, it is easier to say what should be done than to point out the way to accomplish it. The intercourse among manufacturers and users of tools has already become a fact, and very many proprietors of English engineering establishments have travelled, not only to the United States, but also to the leading works on the Continent, and it is largely to such widening intercourse that the awakening to the necessity for change is due. To carry out the other points, however, will involve a practical reconstruction of works, methods, and social relations. Establishments already equipped for general engineering work are not readily or economically adapted to specialised manufacture. Trades unions have shown themselves altogether unwilling to permit the individuality and independence of their members, and any effort to break the shackles has thus far been unavailing. The absence of class-distinction in America renders possible an individual development and ambition, not so easily stimulated in Great Britain, while the tendency to keep the control of establishments within families, regardless of the ability of the chosen ones to meet the actual conditions; these, and many other facts must be reckoned with in attempting to solve the problem which is before the British manufacturer of machine tools.

Refuse Destructors and Power Plants.

THE great interest which was aroused when the first announcements were made of the successful operation of the Shoreditch destructor and power plant, lends especial value to the account of its second year's operation, as embodied in Mr. C. Newton Russel's paper before the Institution of Civil Engineers.

The complete and cleanly destruction of city refuse is in itself a desirable thing, and when with this a considerable portion of the cost can be borne by the utilisation of the heat. the result is doubly valuable.

The Shoreditch plant has now been in operation long enough for reliable data as to its operative expenses to be obtained, and being the largest yet in use, it is the one to which most attention is directed from those interested in the application of similar principles elsewhere. During the past twelve months this plant has disposed of about 26,000 tons of refuse, 92 per cent. of this being ordinary domestic refuse and the balance being straw, paper, and other worthless material. The plant consists of six water-tube boilers and twelve refuse-furnaces of the Manlove-Alliot type, each boiler being placed between two furnaces, the hot gases being delivered to the boilers by short side flues, special grates also being provided under each boiler on which coal may be burned in case of emergency.

All the handling appliances are operated by electricity, the refuse being raised by electric lifts in the trucks into which it is dumped, and run off by overhead trolley system to the place where it is to be discharged. The average daily amount of refuse handled averaged 84 tons, but the deliveries were so irregular that a storage bin had to be provided to receive the surplus, to be drawn upon subsequently.

No coal has been found necessary for mixture with the refuse, the combustion taking place freely, at temperatures ranging from 1,500° to 2,500° F. The principal difficulty found in the practical operation of the plant was the inrush of cold air during clinkering, and a carefully arranged system of dampers is necessary to avoid chilling from this cause.

The clinker residue amounted to about 32 per cent., and its principal use is found in making mortar-concrete, or when mixed with Portland cement it can be used for making paving slabs.

The general application of the heat from the destructors was for the generation of steam for the production of electrical energy, although a portion was used for local purposes. A small portion of live steam was supplied for washing purposes to the public baths connected with the station, while the exhaust steam was used for heating the baths and for warming the free library building, no other expenditure for heating being necessary.

Coming to the important question of cost, it appears that the average cost of burning the refuse during the second year was 2s. 6.9d. per ton, this including labour, supervision, repairs, stores and sundries. Evaporative tests of the furnaces show that with one boiler and two destructor furnaces, constituting one unit, burning ordinary refuse, it was possible to evaporate 2,888 pounds of water per hour, from and at 212° F. This corresponds to an evaporation of about one pound of water per pound of refuse. The heating surface of each boiler is 1,300 square feet, the refuse-grate area 25 square feet, and the coal-grate area 27 square feet.

The total amount of energy sold to customers was 1,031,348 Board of Trade Units (kilowatt-hours), the total amount of refuse burned was 26,201 tons, and the coal consumed 1,344 tons—value £1,308 14s. 8d. At Shoreditch the item for interest charges is 1s. per ton, but owing to the location of the destructor this is much higher than might be the case elsewhere.

Superheated Steam.

In connection with the general revival of interest in the question of the advantages to be obtained by the use of superheated steam, the paper read by Mr. J. H. Ashby before the Cleveland Institution of Engineers contains some features of interest.

When the quantity of steam required for the operation of the various engines, pumps, and other machinery about a great iron works is considered, the disproportion between the amount generated and the results obtained shows that there must be great losses somewhere. Attempts to reduce these losses have demonstrated that the greatest causes of waste lie, first, in radiation and consequent condensation in steam mains; and, secondly, and perhaps the greater of the two, in cylinder condensation.

It requires but little observation in any extended iron works to see that there must be much condensation occurring in the number of steam pipes running in all directions from the boiler house to various parts of the establishment, and although the pipes are generally covered with some form of so-called non-conducting sheathing, yet they are generally without roofs, the lagging is often broken, and even in the best protected cases condensation must occur. The extensive business which is done in the manufacture of so-called steam separators, really traps for condensed steam. shows to what extent this form of loss occurs.

The losses from cylinder condensation were early discovered, and the many attempts to reduce it by jacketing show how fully this evil was recognised. Since the first scientific investigation of the subject by Hirn and his followers, various attempts have been made to counteract the loss from this source, and, with the development of multiple expansion, this has been the main line along which improvement of the steam-engine has been sought.

Superheating of the steam, that is, imparting to it a temperature higher than that belonging to the pressure at which it is generated, was early resorted to as a means of preventing condensation losses, but mechanical difficulties prevented the realisation of success. It was found impossible to secure the desired temperature without carbonising the lubricants then in use, and the superheaters, being weakened by excessive heat, gave out, sometimes with disastrous consequences.

With modern lubricants, and improvements in construction, superheating has again come to the front, and from the experience of steam engineers, at first in Alsace, followed by experimenters in other countries, valuable results have been attained.

The best location for the superheater has been a matter of some discussion, and while early practice indicated the discharge flue from the boiler, it was found that the low temperature of the gases at that point rendered large surface necessary if the desired temperature was to be attained. If, on the other hand, the superheater was placed too near the furnace, fluctuations in temperature occurred, and the apparatus was injured by overheating. An intermediate position is probably to be preferred, and in some forms the whole apparatus is now set entirely apart from the boiler, a separate furnace being employed. In every case provision should be made for protecting the heating surface from injury should the flow of steam not be sufficient to carry off the heat, and in some forms the superheater is so arranged that it can be flooded with water while steam is being raised in the boiler, and subsequently cleared and thrown into the steam circuit.

Assuming that the mechanical difficulties, both as to the superheating and using have been successfully overcome, the economy to be obtained by superheating appears to have been fully demonstrated. The experiments of Unwin and Kennedy in England, and of Schröter, Schmidt, and others, in Germany, show that with 100 to 150 degrees of superheating an economy of 15 to 20 per cent. may be attained. Indeed, in Germany Schmidt offers to guarantee with steam superheated 150° C., a steam consumption of only 3.8 to 4 kilogrammes (8.36 to 8.8 pounds) of steam per horse-power-hour!

In view of the moderate success which has attended other attempts to reduce condensation losses, the advantages of superheating certainly demand attention. There is no doubt that modern lubricants are entirely capable of resisting the effects of the high temperatures, and with metallic packings, and high-class workmanship there should be no trouble in applying steam as highly superheated as may be necessary to secure freedom from serious initial condensation.

The Cost of Calcium Carbide.

Since the first commercial introduction of acetylene as an illuminant it has been recognised that the extent to which it could come into general use would depend upon the cost of the prime material in its manufacture, calcium carbide. As this material has only been successfully produced by means of the electrical furnace, the cost was early seen to be dependent upon that of electrical energy, and it was not difficult to compute the theoretical amount of power required to produce a given weight of carbide. This computation was made by several individuals, with results substantially agreeing, and ranging from 2 to 2.37 horse power hours per pound of carbide.

It was, however, understood, of course, that a lower efficiency was to be expected in practice, and it is only after a period of definite experience that the commercial efficiency of the process could be determined.

Taking such data as are now available, the subject of the actual cost of calcium carbide is discussed in a recent issue of *The Engineer,* and a summary of the results in various localities will be of interest. So far as the efficiency of the process is concerned a comparison of various data indicates that about 60 per cent. of the computed output may be expected; the mean of several reports giving 8,744 h.p. hours as necessary for the production of one long ton of carbide, instead of the theoretical 5,208 h.p. hours.

The question is therefore mainly one of the cost of power, and this is plainly shown by the fact that all plants where carbide is produced in any commercial quantity are placed where cheap water-power is available. Since practically all of these plants are situated out of England the data must be taken from reports published elsewhere. Thus in Switzerland steam power is given as costing £11 or £12 per year, while water-power does not cost above £1, in favoured localities. At Foyers water-power costs nearly £4 per h.p. year, and in England steam is assumed at about £9 per year.

The other factors in the total cost, *i. e.,* material, labour, depreciation, interest, etc., can be computed in much the same manner as in the case of any other manufacturing plant, and from a tabulated estimate for a plant of 1,600 h.p. made by Ludwig, these are shown to amount to about £5 per ton.

Since it is impossible to assume that a horse power year can be produced cheaper in England than £4, and will more probably cost £9, it will be evident that the cost of carbide per ton may be placed anywhere between £9 and £14, according to the cost of power.

REVIEW OF THE CONTINENTAL PRESS

Electric Power in Mining.

In no branch of stationary power application is electric driving meeting with greater favour than in mining work, the ease of subdivision and the facility with which connection may be made with various workings, rendering electrical transmission especially suitable for underground workings.

A paper upon some applications of electric power in various parts of Austro-Hungary by Herr Arthur Bloemendal, in a recent issue of *Stahl und Eisen,* gives an excellent idea of the methods in use on the Continent, and as it contains some details of practical work in large mines in Bohemia and Hungary, especially in connection with the use of polyphase currents, a brief review will be of interest.

The applications of power in mining are diversified, but naturally the greatest proportion is devoted to pumping and hoisting, although in some instances ventilation demands much power, while in coal mining electric coal-cutting machines are coming into very general use.

Herr Bloemendal gives, as an example of the satisfactory working of three-phase currents in mining work, the installation at the Nelson Shaft No. III., at Brüx, where a three-phase generator of 200 kilowatts supplies current for a motor operating a ventilating plant at a distance of one kilometre. The use of electrical transmission in this case enables the generator to be placed in the main power-house and also avoids the expensive hauling of fuel to the inconvenient location where the ventilating shaft is situated.

Several instances are given of the advantages of electric transmission over the use of steam pipes for pumps, not the least being the reduced loss in transmission. The heat from steam pipes is often very objectionable, while for pumps which require to be frequently moved, as is the case in development works and shaft sinking, electricity has been found most useful. At the Budweis colliery a traveling pump was required to be operated on a track inclined at an angle of 23° from the horizontal, and to traverse a passage only 1,300 millimetres high and 900 millimetres wide, and at the same time a capacity of 400 litres per minute against a head of 240 metres was required. It would have been impossible to fulfill the conditions by the use of steam or compressed air, but a very satisfactory electrically-driven pump was designed and is now in use.

Pumps for use in shaft-sinking are operated with great advantage by electricity, especially because of the ease with which the current can be delivered to the suspended mechanism. By providing a cable drum at the mouth of the shaft, the conductor can be fed out as the pump descends, and thus all the inconvenience formerly experienced with steam pipes is avoided, especially the leakages at imperfect joints and the delay incident to the insertion of new lengths of pipe.

For all such applications of electric power the polyphase current is found to be satisfactory, but for general traction purposes the continuous current is still preferred. For this portion of the plant the polyphase current can be conveyed to advantage to the point near the operation of the haulage tracks and then, by use of a rotary converter, transformed into the desired continuous current.

Herr Bloemendal gives a description of the plant at the Hernadthal Iron Works, at Krompach, in which a polyphase current of 3,000 volts pressure is transmitted over a distance of 6 kilometres by uncovered wires on wooden poles, and there transformed to a continuous current of 500 volts for operating a mine haulage plant. A portion of the polyphase current is also transmitted a further distance of 2 kilometres, and transformed for use in electric rock drills.

There has been some doubt expressed as to the reliability of electric machinery in mines, and, as the results of breakdowns may be most serious, this is an important question. The greatest cause of trouble has been that of short-circuiting, due to defective insulation, but the improvements in insulating materials have rendered accidents from this cause quite remote in new installations, while, with proper care in mounting and supporting conductors, there is no occasion for insulation to become seriously damaged in operation. Motors and generators are now made so as to be practically unaffected by dampness, and Herr Bloemendal gives an example of a generator directly connected to the shaft of a Pelton water-wheel and placed in an underground chamber where the moisture was so excessive that water was constantly trickling down the walls. Although the dynamo was of the open type, no trouble was experienced during a period of more than a year and a half.

So far as the ignition of mine gases from sparking is concerned, this portion of the problem has apparently been met by the production of non-sparking dynamos, and the advantages of electric lighting are such as to render electricity safer than the older methods.

Liquid Carbonic Acid.

Carbonic acid was one of the first gases to be liquefied by pressure, the gas for this purpose being generated from marble dust and chips by the action of a dilute acid, sulphuric or hydrochloric; the gas which is used for the production of carbonated drinks still being generally produced in this manner. The convenience of the liquefied gas for such purposes, is such that it has become a regular commercial product, being generated and compressed in cylinders in portable form.

A recent issue of the *Moniteur Industriel* contains an account of the installation of a plant at Rouen for the purpose of collecting the carbonic acid gas given off during fermentation in breweries and distilleries, thus securing what has hitherto been considered as a waste-product, and making it of commercial value.

The idea of utilising this waste product originated with M. Louis Meeus, of Wynghem, and the method has been put into practical operation in a large distillery, producing 300 hectolitres (nearly 8,000 gallons) of alcohol per day. It has been computed that in this establishment the daily production of carbonic acid is 28,000 kilogrammes (nearly 62,000 pounds), all of which has been therefore permitted to drift away into the atmosphere. By a system of exhausters this gas is now collected and delivered to compressing pumps, by which it is liquefied under a pressure of 55 atmospheres, the liquid being collected in steel cylinders of 10 kilogrammes capacity each. The liquid gas, thus collected, can be shipped like any other merchandise, and in this form it is well adapted for all the commercial operations which have generally been accomplished by gas manufactured on the spot.

The advantages of such a convenient supply may revolutionize certain industries, such as the charging of siphons, the local production of intense cold, and the carbonating of various drinks, and the recovery of this by-product may therefore be a matter of material industrial importance.

Mining Machinery in the Transvaal.

The rapid development of the mining interests in the Transvaal has made that section probably the best equipped mining region, so far as modern machinery is concerned, to be found anywhere. This evidence of the possibilities of the region from an engineering standpoint, is well brought out in an article by Herr Kurt Schweder in a recent issue of *Glückauf*.

Herr Schweder emphasises the fact that, great as is the importance of the mining interests of the Transvaal, a recent visit to the country convinced him that as a field for the application of modern machinery the opportunities are at least equally great.

According to the statistics of 1898, there were at that time in operation in the Witwatersrand district, 1,593 steam boilers, 294 engines, for general motive power, 407 hoisting engines, 133 air compressors, and 222 pumps.

Water-tube boilers seem to have found favour, and several well-known types of German and American design are in extensive use. The coal used is inferior, an evaporation of 7 pounds of water per pound of coal in the calorimeter being about as good as can be obtained, the minimum proportion of ash being about 30 per cent. In practice it is found that only about half the usual guaranteed evaporation can be obtained, as compared with the performance of similar boilers with suitable fuel elsewhere, and this fact should be borne in mind in making plans for steam plants. Herr Schweder advises that an evaporation of only about 60 per cent. of that shown possible by coal analysis can be expected in practice.

It is urgently recommended that feed-water purifiers be used, as the mine water is charged with sulphates and also contains much mud and sediment. The importance of this fact was not fully realised until after many boilers had been seriously damaged by heavy formations of scale.

Chimneys are usually made of sheet-iron, being built in sections and erected with the aid of wooden scaffoldings, and finally strengthened by wire guys.

Air compressors have been extensively used since the time of the early workings, being necessary for the operation of rock-drills, boring in the hard reef. The earlier compressors were constructed with heavy cast-iron flap-valves, but the later designs of the best American and German makers have since been installed, with mechanically operated valves, so that probably the latest developments in this important branch of engineering are best represented in South Africa.

For motive power many excellent types of engines are in use, various modifications of the Corliss engine being seen. These are operated with much care, indicator cards being taken daily and entered with accompanying data in a log book as a portion of the records of the plant. High-speed, direct-connected engines of the Willans type are much used in connection with dynamos for electric plants, although in a few instances slow-running engines are also found in use for this purpose.

The stamp mills are generally driven by direct-connected engines in order to avoid the difficulties arising from unequal settling of foundations, but in some instances a flexible rope transmission is used, employing Manila or cotton rope.

Pumps are found in great variety and number. In some cases the service required of pumps is difficult and exacting. For the handling of the tailings from the copper plates pumps were first used, but it was found that the sand present in the water cut the valves, cylinders, and plungers to such an extent that bucket wheels had to be substituted. For handling slimes centrifugal pumps have been found very satisfactory.

In regard to mine pumping, no very great difficulty has been experienced with volume of water, indeed it might be advantageous if there were a greater flow, in order to dilute the acidity, since at present the mine-water contains 0.04 per cent. of sulphuric acid.

Winding engines are naturally important in a region where such great depths have been attained. The operations of these engines are controlled by a number of levers, not only for the operation of the engines themselves, but also for the control of clutches, brakes, and disconnecting gear. Much experience and skill is required of the engineers in charge of these machines, and for the past three years the Transvaal government has required men aspiring to such positions to pass a special examination, the strictness of which may be inferred when it is stated that in the last year only 56 out of 112 applicants succeeding in passing.

The present disturbed condition of affairs in this important mining country will doubtless soon give place to renewed activity in mining operations, and with it must come a demand for general and special machinery of the highest class, and in this connection the experience of Herr Schweder will be found a valuable guide.

The Mont Blanc Railway.

There has been some talk at various times about a railway to the summit of Mont Blanc, and now we have, in a recent issue of the *Moniteur Industriel*, a detailed account of the scheme, which may form one of the striking achievements of the coming century.

The starting point of the road is intended to be at Les Houches, close to the line from Fayet to Chamounix, now in course of construction, and the road will enter a tunnel immediately below the village of Taconnaz, at an altitude of 1,100 metres. The line will then follow the ridge along the left side of the glacier of Taconnaz, and by a tunnel 5 kilometres in length will reach the summit of the "Aiguille du Goûter." This tunnel, running up along the mountain ridge, will be pierced with openings at various points along the side, the whole forming a magnificent rocky gallery affording views of the peaks and glaciers surrounding Mont Blanc. At the summit of "Aiguille du Goûter" there will be a large railway hotel, which, situated at an altitude of 3,843 metres, will be provided with all the necessaries for protracted sojourns, and is expected to become a popular resort. From this station the excursion to the glacier will start, and from here a tunnel will be driven directly under the "Dôme du Goûter," in the direction of the Vallot observatory, where a station is to be established at an altitude of 4,362 metres, on the "Rochers des Bosses."

In order to reach the Janssen observatory the road must be conducted under the Rochers des Bosses, reaching the Rochers-Rouges, where, at an altitude of 4,580 metres above the sea, the terminal station will be situated. This point is only 230 metres below the summit of Mont Blanc, and from here an inclined cable-railway will be used to enable the last portion of the journey to be completed, and the final altitude of 4,810 metres attained.

The total distance traversed by the rack railway and the cable road will be 10 kilometres, and it is now estimated that by the month of July, 1902, tourists will be transported to the "Dôme du Goûter," an altitude of more than 3,508 metres.

It is proposed to make the terminal station entirely underground, with alcoves excavated in the rock for restaurants and other industries, the whole thus being entirely sheltered from the exposure to the cold and atmospheric disturbances incident to the great altitude.

Such is the outline of the scheme proposed by the French engineer, M. Saturnin Fabre, and in view of the success which has attended the existing Alpine railways there seems to be no good reason why it should not be realised, if the financial side of the problem can be successfully met. The railway to the summit of the Jungfrau is now well under way, and offers difficulties not less imposing than those which appear in the Mont Blanc scheme, and the popularity of the region among tourists from all parts of the world should render this project equally attractive from a commercial point of view, if the constructive cost is not prohibitive.

By the use of electricity as a motive power, derived from the ample sources of hydraulic power in the vicinity, the expense of transporting coal will be avoided, practical experience with electric mountain roads having fully demonstrated the success of electric power for this work.

The Mont Blanc railway, with its observation galleries overlooking the valleys of Chamounix and Sallanches, and with its panorama of the whole of the French, Swiss, and Italian Alps, cannot fail to be a point of attraction for travelers from all parts of the world, and it is to be hoped that the plans for its construction will meet with a successful realisation.

The Transformer Turbine.

The advantages of the direct connection between turbine and electric generator have been abundantly shown in many modern hydraulic electric stations, and either in the vertical or horizontal form this arrangement has become generally approved. When, however, the head of water available is not great, it is not practicable to attain a sufficiently high rotative speed upon the turbine shaft with the ordinary construction, and in such instances it has been usual to interpose some form of gearing to obtain the desired speed.

In a recent series of papers in the *Schweizerische Bauzeitung,* Professor Franz Prásil of the Zurich Polytechnic, discusses what he terms the "transformer" turbine, and shows the practicability of obtaining from low heads sufficiently high rotative velocities to permit of the use of direct connected dynamos.

The principle upon which this apparatus is constructed is that of a form of what may be called "hydraulic gearing," the compound motion of two co-axial wheels being united and hence multiplied in corresponding proportion. This is accomplished by causing a portion of the water to flow through a wheel of the Jonval type, which wheel, revolving, carries with it a set of guide vanes which direct the balance of the water against the buckets of the main turbine below. This last turbine is thus fed, not from stationary guide-vanes, as in the ordinary Jonval wheel, but from vanes which are already in motion, and hence it receives the sum of the motions of both systems.

The geometrical relations of the various parts of this combination are very fully worked out by Professor Prásil, and in conjunction with Herr Naville, the chief engineer of the well-known firm of Escher, Wyss & Co., some wheels of this type have been constructed and tested.

A very full account of the tests is given in the paper, and the data and results are tabulated and shown in the form of diagrams, but a general summary only can be given here. The testing weir of Messrs. Escher, Wyss & Co. was used, so that every facility for the measurement of head, speeds, brake power and efficiency was available. The head of water varied from 2.7 to 2.84 metres, and the power developed at full gate was nearly 40 h.p. Under these conditions the speed attained by the single turbine was about 70 revolutions per minute, while the transformer wheel practically doubled this, reaching 131 to 134 revolutions.

The efficiency tests do not show as high results with this form of wheel as with the best examples of single turbines, reaching only about 54 per cent., but this feature is doubtless capable of further improvement, and when it is considered that the losses due to gearing are avoided it is a question whether the commercial efficiency is not as great in one case as in the other.

This novel departure in hydraulic motors, while special in its nature, may find numerous applications, and its development will be watched with interest.

Deepening Mine Shafts.

In the coal regions of Belgium many difficulties have been encountered in sinking the shafts to much greater depths than were originally intended or expected. For this reason the account of the methods recently adopted, as described in a paper by M. Julien Linet in the *Revue Universelle des Mines,* is of especial interest, and the system there shown may find equally satisfactory application elsewhere.

The principal difficulty encountered was that of the character of the strata through which the shafts were to be sunk, requiring the lining to be substantial. The coal measures have a dip of 50° to 75°, and between them are strata of schist and sandstone of varying degrees of solidity, with occasional veins of water.

The especial shaft discussed in the paper was an air shaft, carried down parallel to the vertical hoisting shaft of the mine, and it was desired to increase its depth from 480 to 580 metres, or a deepening of 100 metres. This work may broadly be divided into two portions, the excavating and the lining, and it was mainly in the latter portion that the method discussed was employed.

The excavating called for no especial devices, hand drills being employed, and the blasting being performed by safety mining explosives fired by electricity. The débris was raised in steel skips of about 0.15 cubic metre capacity, by the use of a steam windlass.

During the first 50 metres of the work the lining of the shaft, which was to be 3 metres internal diameter, was composed of brick work masonry, a temporary bracing being employed to support the sides from caving during the work. This bracing was composed of circular frames made of channel-iron and provided with struts arranged in such a manner as to leave a central opening of sufficient size to permit the hoisting of the skips. As the deepening progressed the brick lining was constructed in the usual manner, the iron bracing rings being lowered to the deeper portions of the excavation.

This system of masonry lining has generally been considered the best for colliery shafts in Belgium, but it has various disadvantages. It is expensive; it is not rapidly executed; and it is by no means impermeable. For these reasons, as well as because it was thought most desirable to be able to carry the lining down simultaneously with the excavation, it was determined to attempt to improve upon the brickwork lining for the second 50 metres of the work.

The idea was to carry down a continuous lining of concrete in such a manner as to form a complete monolith when the shaft should be finished, and it was in the execution of this plan that the especial interest of the work appeared.

In order that the concrete should form a continuous mass it was necessary to have the work proceed regularly, step by step, in such a manner as to be practically continuous, and this involved a movable centering supported in the middle of the excavation, with a space between it and the earth walls in which the concrete could be rammed. This movable centering, which was 3 metres in diameter and 1 metre long, was formed in segments in such a manner that by releasing one portion, the whole could be contracted and loosened to a sufficient extent to permit its descent. The excavation was kept in advance of the centering by 3 or 4 metres, no difficulty being experienced from caving-in within this space, and as soon as the débris was removed the centering was lowered and the concrete filled in.

During the filling the centering was supported on wooden beams braced across the excavation, while the concrete, lowered in buckets, was carefully rammed into the annular space. It was found that the concrete was thus forced into the irregularities of the excavated walls in such a manner as to be firmly attached at once, so that there was no danger of movement when the centering was shifted, and the work proceeded rapidly as soon as the workmen acquired experience in the method.

The concrete was made from slag cement, which gave excellent results under test, and which was much cheaper than natural cement at the locality. The concrete was composed of cement, granulated slag, and pebbles in the proportions of 1 : 2½ : 4½; tests of this combination showing a crushing strength of 300 kilogrammes per square centimetre (4,266 lbs. per sq. in.).

A comparison of the advantages of the concrete lining and that composed of brick masonry is given by M. Linet, and as it is made upon two sections of the same shaft the other conditions were so nearly equal that it may fairly be considered as showing the relative methods of the two systems.

The economy, which was shown to be largely in favour of the concrete, was dependent upon several elements. Lower-priced labour could be used, more rapid progress was made, and the material cost less. The details of the cost and progress of each system are tabulated in the original paper, but the general results are best shown by the conclusions, which are as follows:

1. A daily progress, both as to excavating and lining, of 29 per cent. greater speed with concrete than with brickwork masonry;

2. An economy of 82 per cent. in the cost of labour;

3. An economy of 148 per cent. in the cost of material.

Since this shaft was intended for a ventilating passage, another important advantage appears in the smoothness of the surface, this reducing the frictional resistance, there being no joints or other roughness to impede the flow of air.

The success of this work may lead to its general adoption in Belgium, and the method is certainly worthy of consideration elsewhere.

The Wear of Gear Teeth.

The correct form of gear teeth is a subject to which probably more study has been given than almost any other detail of machine design, and from the time which is given to it in some courses of study it might almost be supposed that the tracing of tooth-outlines was the main object of the mechanical engineer. In all these studies, however, one important feature of gear tooth action has hardly been considered, namely, the influence of the shape of the tooth upon the wear. Several years ago a paper upon this feature was presented before the American Society of Mechanical Engineers by Professor Reuleaux, and now we have a very full treatment of the same subject in a series of papers by Herr O. Lasche, in the *Zeitschrift des Vereines deutscher Ingenieure.*

The importance of this matter is shown by the fact that electric traction and other applications of electric driving have led to a much wider introduction of high-speed gearing than has heretofore been made, and in many instances these applications are surrounded by conditions which conduce to rapid wear.

It is evident that the question of wear

compels the consideration of many other conditions than those involved in the mere kinematic problem of the transmission of motion at a determinate velocity-ratio, the wear depending upon the pressure on a given unit of tooth surface, upon the extent and nature of the sliding, and upon other working conditions to be considered in each specific case.

Heretofore the best form of tooth outline has been decided solely by the theory of geometrical relation of the parts during the transmission of motion, but when the question of wear is taken into account it will be seen that the form of tooth may have an important influence upon the life of the wheel.

The two forms considered by Herr Lasche are the epicycloid and the involute, these curves, or some close approximation to them, being practically the only ones in general use. Assuming that these are practically equal, so far as ease of construction and correctness of transmission of motion are concerned, he takes up the difference in wear in each case, giving some very interesting and instructive diagrams. The wear may be considered as dependent upon the following three conditions: the specific pressure of the two tooth-surfaces upon each other, the coefficient of friction of the materials used, and a coefficient depending upon the extent to which the two surfaces roll and slide upon each other.

Assuming the total pressure to be uniform during any period, the specific pressure depends upon the area over which the total pressure is distributed, and it is evident that this area is governed by the curvature of the surfaces. If the materials were absolutely inelastic there would be but a line-contact in any case, but in practice the area of contact depends upon the elasticity of the material and the radius of curvature of the surfaces. Since the curvature is by no means constant for either form of tooth, it follows that the specific pressure varies during different portions of the engagement of the teeth, and there will be variations in wear upon different portions of the tooth from this cause.

The question of relative sliding and rolling action is carefully studied by Herr Lasche, large diagrams of teeth of both forms being shown with the faces divided so as to show the extent to which the sliding occurs, and the relative results being plotted in the form of curves. Similar curves are given to show the varying pressure at different points of engagement, and by combining the two curves the extent and distribution of the wear can be theoretically deduced. From these it is seen that the wear on involute teeth should be much more irregular than of epicycloidal curves, the pressure and rubbing being especially high at the beginning of engagement in the case of the former.

Comparing these theoretical conclusions with the behaviour of teeth in practice it will be seen that the theory is well borne out. A number of photographs are given of gear teeth which have been badly worn in service, and the distribution and extent of wear in the two systems show that it is quite possible to determine beforehand the character of action for a given form of tooth, so far as durability is concerned. The question of the "coefficient of wear," first introduced by Reuleaux, is a matter which should undoubtedly be taken into consideration in connection with the whole subject of gear design for such service as is involved in tramway work, and with an intelligent study of the subject a much longer life for gear wheels may be expected.

Hydraulic Power in Italy.

Several months ago the question of the importance of the development of its numerous water powers upon the industrial future of Italy was discussed in the leading pages of this magazine by Signor Enrico Bignami, and now we have an extended discussion of the same subject by Ing. A. Raddi, in the pages of the *Giornale dei Lavori Pubblici*.

After showing the importance of the utilisation of natural sources of power in a country destitute of coal, Signor Raddi goes on to discuss the feasibility of long-distance electric-power transmission, especially in view of the recent propositions of Professor Forbes; and in the same connection he shows how successful have been the great Italian hydraulic-power plants near Rome (Tivoli), Genoa (Gorzente), Paderno, and Vizzola. He then takes up a phase of the subject, which, so far, is peculiar to Italy, namely, the Government regulations controlling the utilisation of hydraulic power.

This forms an important feature of the problem, since the granting of water rights has become somewhat involved, and consequently the development of hydraulic power proportionately impeded.

In order to prevent valuable water rights from being taken up and held speculatively under certain older regulations, a circular was issued by the Minister of Public Works in 1898, requiring concessions to be withheld until certain official investigations had been made, especially with a view of ascertaining the possible value for governmental purposes. Subsequently to the issuance of this circular and its later withdrawal, a new law has been drawn up which provides for the supervision and regulation of hydraulic-power concessions, the especial point in view being that of the development of national industry rather than the immediate production of revenue by taxation. So far as the present industrial condition of the country is concerned the importance of such action will appear when it is realised that 4,000,000 metric tons of coal are now imported annually, representing a value of 120,000,000 lire in gold.

The total amount of power available is computed broadly from the best statistics as that producible from 1,000 cubic metres per second, with a mean fall of 600 metres, or 8,000,000 h. p., or, if a number of small streams are included, this may safely be increased to 10,000,000 h. p. Of course no accurate estimate can be made until the available streams have been fully surveyed and mapped, and although this work has been authorized by the Government, it has only been carried out to a very small extent up to the present time, but this estimate agrees very closely with that made by MM. Gillian and Blondel for France in 1898.

Signor Raddi gives an interesting discussion of the question of the cost of a hydraulic-electric horse-power, and incidentally of the cost of a steam horse-power, and in view of the interest which has attached to similar discussions elsewhere his conclusions are here abstracted.

Assuming that with modern steam engines of 50 to 100 h. p., the coal consumption is 1 to 1.2 kilogrammes per h. p. hour, the cost of a steam horse-power is found to range between 1,450 lire for a one horse power engine, to 150 lire for a 500 h. p. engine, per year of 3,300 working hours.

The cost of an electrical horse-power naturally depends more upon the cost of installing the permanent plant than upon the subsequent operating expense, and to this cost of building, fixtures, machinery, etc., must be added the very variable cost of the dam, canal, and tail-race. In Italy the rapid falls cause the conditions to resemble somewhat those existing in Switzerland, and from the existing plants in Germany and Switzerland, together with those which have thus far been erected in Italy, an average cost may be deduced which will serve as a basis for future estimates. Thus the plant at Zurich, according to Saldini, cost 500 lire per h. p. at the power house, or including the cost of the electrical plant and the transmission to Zurich and Winterthur, 1,200 lire, this not being a very low cost. The plants at Paderno and at Vizzola have cost, for the hydraulic works and power house alone, about 600 lire per h. p., and from 1,000 to 1,200 lire including the electrical portion. From such data the cost of the plant proposed on the Magra for the supply of electrical power to the arsenal at Spezia, has been estimated at 1,500 lire per h. p. for a capacity of 1,700 h. p. total. Much lower costs than these are possible when the power house is situated in the mountains. Thus the plant on the Isère cost only 170 francs per h. p., and one in Haute Savoie of 6,000 h. p. from a fall of 140 metres cost but 83 francs per h. p.; but unless the industrial operations are such as can be economically conducted in such localities, the cost of transmission may render the final economy not much greater than more expensive plants in better commercial locations. For metallurgical operations, and for some electro-chemical works, however, it may be found equally convenient to have the works situated in the mountains, and the increased cost of coal in such localities adds to the comparative advantage of hydraulic power.

REVIEW OF THE AMERICAN PRESS

Electric Power Stations in New York.

THE development of the electric power station, especially in connection with electric traction systems, is strikingly shown in the case of New York City, where there are now under erection two of the largest steam-electric power plants in the world, and from accounts in the *Engineering Record* and the *Street Railway Journal* some description of these latest examples of power-house work is abstracted.

The determination to concentrate the power of a system at a single large station is the outcome of the development of the polyphase system of electrical generation. The 500 volt direct current system would have involved the erection of a number of stations at various points, as it would have been practically impossible to transmit the current over the 220 miles of system, but by the generation of polyphase alternating current, transmitted at a high voltage to distributing points where it can be reduced to a 500 volt direct current by means of rotary converters, the giant power station has become a possibility.

The station of the Metropolitan Street Railway Company occupies an entire block between 95th and 96th streets on the East River, thus permitting the delivery of coal direct from barges to the bunkers over the boilers. The proximity to the river also permits an abundant supply of water for condensing and other purposes; the only objection being that the saltness of the water prevents its use for boiler feed, rendering surface condensers necessary.

This plant, of which a very complete description is given in the *Engineering Record,* contains 11 units aggregating from 45,000 to 60,000 h. p., the latter being the maximum and the former the most economical load. The construction of these large compound engines is well shown in the illustrations to one of the leading articles in the January issue of this Magazine, especially as photographs are given of the work as partially erected, and the fact that this plant represents the typical practice now attracting so much attention and discussion in Europe lends especial value to the publicity which has been given to it.

The general arrangement of the power-house presents no wide departure from standard American practice, the use of water-tube boilers in successive stories, with coal bins above, and with mechanical conveyers for coal and ashes, being well known and approved. The main interest, other than that which attaches to the size of the plant as a whole, lies in the massiveness of the engines, these being provided with shafts of fluid-compressed steel, hollow-forged, 37 inches in diameter at the fly-wheel, 34 inches at the journals, and 30 inches at the cranks. The dimensions of shafts and bearings which American experience has found advantageous has been made the subject of some discussion abroad, but it must be remembered that stiffness as well as strength must be considered. In the case of marine engines, the conditions are so different as to create no precedent which can apply, the load being almost altogether such as to produce torsional stresses, while in the power-house engine a very heavy lateral stress is produced by the weight of the revolving fields and heavy fly-wheels. When in addition to this it is remembered that a very slight deflection is sufficient to destroy the magnetic balance, it will be seen that there is good reason for the adoption of dimensions which at first appear to be excessive.

The other station to which reference has been made is still larger, being intended for a capacity of 100,000 h.p., this being the new power house of the Third Avenue Railroad Company, of New York. This station is but recently commenced, but the plans for the buildings and equipments are very fully given in the *Street Railway Journal,* so that the two plants may be fairly well compared.

So far as the engines and generators are concerned there is little to be said, as the standard practice above described has also been adopted in this case, there being

16 direct-connected cross-compound engines of 4,500 to 7,000 h.p. capacity, with the fly-wheel directly attached to the revolving member of the generator.

The main feature of this plant lies in its subdivision into four sections of four units each. Each section is served with steam by a double-decked battery of boilers occupying one-quarter of the boiler house. Each quarter in turn has its independent flues, economizers, stack, auxiliary mechanical draft, and condenser. Equalizing flues are provided, to allow each stack, with the aid of mechanical draft, to relay the other stack on the same side of the house. The steam piping, constructed upon the equalizing-main system, is so connected as to allow each section to relay each of the other three, while the four condensers are so multiplied together in their connections as to work as one unit, three having the requisite capacity to admit of one being cut out. This arrangement gives practically four plants, capable of being operated as one homogenous plant, the advantages of which will readily be seen.

Both plants are equipped with mechanical stokers, it being found advantageous both for mechanical and administrative reasons to be free from the difficulties of hand-firing. The stokers, being adapted to use either hard or soft coal, separately or mixed, obviate to a great extent the possibility of interference or delay by reason of strikes or combinations among coal miners, and the avoidance of the necessity of employing a small army of firemen who might in case of labor troubles interfere with the continuous working of the plant. The Third Avenue plant contains, among other improvements, the use of central condensing apparatus, instead of the provision of a separate condenser for each engine, and plans have also been made for a very complete system of oiling from tanks, using pumps for the movement of the oil and filtering and cleaning devices for the return oil.

The extent to which central station practice has grown in America is hardly appreciated in other parts of the world, and an examination of these accounts of the two largest and latest installations will furnish much information concerning present practice on a large scale.

The Lawrence Sewage Experiments.

Sanitary engineering has become greatly indebted to the Massachusetts State Board of Health, not only for the many valuable investigations which it has conducted, but also for the complete manner in which the results of such work have been made public, and the reports of this body are filled with valuable information concerning original work.

The report for 1898, which has been recently issued, contains some valuable information concerning the treatment of sewage, based upon investigations which have been carried on at the Lawrence experiment station, and from an abstract of this portion given in the *Engineering Record* some points are taken.

The Lawrence experiment station has been in operation about 11 years, and during that time it has made several hundred investigations of sands, soils, etc., in connection with the chemical and bacterial analyses of sewage, to assist in the construction of sewage disposal plants in various towns and cities of the state.

Since the development of the septic processes, in England and elsewhere, a septic tank has been constructed at Lawrence, and it is upon the behavior of sewage which has undergone septic treatment and is subsequently passed to various filter beds that the present report mainly treats.

There are several points which must be considered in discussing sewage purification. The object of the purification is to convert the organic matter into inorganic matter. The first action is that of the dissolved oxygen, which oxidizes the carbon, while the hydrogen and nitrogen form ammonia. When the oxygen is exhausted putrefaction sets in, the organic matter continuing to break up into simpler combinations, but producing hydrogen compounds with sulphur, phosphorus, and carbon and consequent foul odors.

The final break-up of the organic compounds is effected by bacterial decomposition, which takes place in properly constructed filter beds, such beds being composed of sand, cinder, or coke, the passage of the liquid through the finely divided material enabling the bacterial action to take place more or less completely. One of the difficulties with such filters has been the formation of a scum of organic matter upon the top, this preventing the ready descent of the liquid into the lower layers of the bed. The experiments at Lawrence give information as to the action of the septic tank in rendering the greater portion of the organic matter soluble, and thus providing a material much better adapted for treatment by the filter beds.

The tank at Lawrence is an air-tight wooden box divided into two compartments by a central partition, the sewage flowing into one side, over the partition into the other. After the sewage has remained in this tank for 24 to 36 hours it is drawn off, and it is found that the amount of suspended nitrogenous matter has been reduced about one-half and is much more finely divided. The albuminoid ammonia is decreased by about 48 per cent., and the carbonaceous matter 43 per cent. This effluent has been tried upon various filter beds, with varying results. The first of these beds contained 5 feet depth of sand having an effective size of 0.26 mm., and was operated for 7 months at a rate of 100.000 gallons per acre daily and for the remaining 5 months at double this rate. The results were not altogether satisfactory, the effluent being always somewhat turbid, and having a disagreeable odor, while with sewage in a less advanced state of putrefaction this bed would have given a clear, odorless effluent. The reason advanced for this is that the gases generated in the septic tank, and yet remaining dissolved in the sewage, were inimical to the life of the oxidizing bacteria and prevented them from performing their usual effective work in the filter.

The second experience was with a bed containing pieces of coke of sizes between ⅛ and ¼ inch. The outlet of this bed was closed and the sewage allowed to flow in until the surface was just covered, this requiring about 8 hours. A further period of 2 hours was allowed to elapse and the outlet then opened and the filter allowed to drain slowly. Although this bed was operated at the high rate of 800,000 gallons per acre daily, it gave much better results than the first bed, the effluent coming off clear and odorless, the action being much better than in similar beds with fresher sewage. A third trial was made with a bed similar to the first, but containing finer sand, but although the results were better than in the first case, they were not so satisfactory as those with the coke.

Some subsequent experiments with filter beds of different kinds are discussed in the paper, but the main feature of all the investigations is the demonstration of the importance of providing a filtering material sufficiently coarse to permit the sewage to enter promptly into the layers and there be retained long enough to permit the bacterial action to take place; while the surface of the particles should be rough enough to hold the air as much as possible. An aeration of the sewage was also found to improve the action materially, doubtless by permitting the escape of the gases inimical to bacterial life and also by aiding the contact with oxygen.

The whole conclusion of the paper is that with properly prepared filter beds and a septic tank of moderate size, there is no difficulty in so purifying foul sewage as to produce a clear, odorless effluent at a rapid rate. In the light of these valuable experiences the introduction of proper purification plants should be greatly facilitated and extended.

The Level of the Great Lakes.

The proposition to raise and control the level of the water in the Great Lakes, which is now being seriously discussed, is one of such importance as to warrant careful examination, especially as it has the approval of the Government Board of Engineers of Deep Waterways. From an abstract of the preliminary report of the Board, given in a recent issue of *Engineering News,* together with an editorial discussion in the same issue, it appears that the project is altogether feasible, that it can be accomplished at a moderate cost, and that the immediate benefits can be directly valued at many times the cost of the work.

Briefly, the proposition is to construct a regulating dam on the Niagara river not far from Buffalo. The regulating feature will be accomplished by making a fixed weir with movable sluices, so that the outflow of Lake Erie may be controlled at all times, and according to the report it will be feasible in this manner to maintain the level in Lake Erie about 3 feet higher than the usual stage of water during the low-water period in the latter part of the season of navigation. Since the aggregate cost of improving Lake Erie harbors has averaged about $1,000,000 for each foot of permanent depth secured it appears that the value of this raise in level would be $3,000,000, while the cost of the improvement works is estimated at but $800,000.

The extent to which it is proposed to raise the level will in no case cause damage, nor involve expensive changes, since the practical effect will be to maintain constant mean high water in Lake Erie, which will make a corresponding increase in low water depth in Lake St. Clair of 2 feet, and in Lake Huron and Lake Michigan of 1 foot. Lake Superior is beyond the range of effect, but as the waters of this lake reach their high stage in September the maximum discharge into Lake Huron is produced just at the time when that lake is being lowered most rapidly by evaporation and outflow.

One of the especial advantages to be gained by the raising of the lake levels is in connection with the work on the Detroit river. At present there is less than 18 feet depth over the shoals at low water and the necessity of deepening works has been demonstrated if the increasing commerce is to be handled. The increase of 2 feet in depth, which the works at the outlet of Lake Erie would produce, is estimated to save more than enough excavation to pay for the construction of the regulating works.

It must be remembered, however, that there are other questions to be considered besides the mere cost of the actual regulating weir, and its accompanying breakwaters and locks. Any restraint set upon the normal condition of flow in such an extensive system of waterways will affect to some extent the regimen of the immediate waters which supply them and which they feed. Whether any disturbance of vested right may thus be caused remains to be seen, but it is evidently important that such contingencies demand a thorough and discriminating examination of all the possibilities in the problem.

It is noted that the measurements of the flow of the Niagara river, made both by the Board's engineers and by United States engineers, show that there has been a continuous decrease in the discharge. The measurements made in 1869 gave a discharge of 265,000 cubic feet per second, those made in 1890-91 gave but 230,000 cubic feet, while the present measurements show but 220,000 cubic feet, and comparisons reveal a similar decrease in the discharge of the St. Clair and St. Lawrence rivers. The cause of this steady diminution of flow has not yet been made clear.

It is, of course understood that any construction affecting the level of the Great Lakes necessarily becomes a matter for international agreement, and nothing can be done until a proper arrangement has been made between the governments of the United States and Canada, but there is no reason to expect any opposition from Canada in a matter in which she has everything to gain and nothing to lose, as it is proposed to conduct the work entirely at the expense of the United States government.

Power Developments at Niagara.

Since the original starting of the great plant of the Niagara Power Company numerous additions have been made to the plant, these including improvements in minor details and extensive additions to the establishments supplied by it. From a very full account by Mr. J. E. Woodbridge in the *American Electrician* some account of the additions is taken, reference to this important paper being necessary for those who desire fuller information than is here available. The original plant was started with three turbines of 5,000 h.p. each, although the tunnel which forms the tail-race of the wheels was constructed for a much larger capacity. During the past two years the generating plant has been increased by the addition of seven 5,000 h.p. machines to the original three. Several new local electro-chemical loads have been added at Niagara Falls, the greatest of which is the new works of the Union Carbide Company, which already absorb 15,000 h.p., or an amount equal to the entire original capacity of the Niagara plant. The long-distance transmission of power has been greatly amplified: 3,000 h.p. being used by the Buffalo General Electric Company, 27 miles away, this being transformed to four different styles of current for central station service, and all its steam stations being discontinued.

It was originally intended to increase the plant by adding units of 5,000 h.p. until 16 such units had been started, but it is now probable that the present plant of 50,000 h.p. will remain unchanged for some time, and that the privileges on the Canadian side will be developed.

The five units which were added in 1898 were discussed in these columns at that time, and these have been found to embody so fully all the necessary improvements that no further changes have been made in the two latest units. Mr. Woodbridge's paper gives a full section of one of the 5,000 h.p. generators, showing very clearly the changes over the first form. The principal improvements are the method of supporting the bearings in accurate concentric alignment with the frame, and the arrangements for cooling. The centering of the bearings is effected by the use of tapered seats, into which the spiders holding the bearings proper are forced downward by means of bolts. The bearings are piped for an oil-circulating system, while cored chambers in the body of the bearings are piped for a water-circulation. Circulating passages for water are also cored in the ribs of the frame to which the armature laminations are dovetailed, so that the heat can be carried off, and this, together with the air circulation, are found to carry away much of the heat which was such a noticeable feature of the earlier generators. The necessity for providing for the removal of so much heat does not indicate that the generators are not of high efficiency; as a matter of fact the efficiency attained is 98 per cent., but with a plant of this size the 2 per cent. to be dissipated amounts to 100 h.p., and being concentrated into a comparatively limited area it is necessary to provide carefully for its removal.

As an example of the manner in which the work is divided, at a time when eight of the ten generators were in operation, it appears that two machines were run in one battery for the operation of the long-distance transmission loads of Tonawanda, Buffalo, and Lockport, one battery of three generators was running on the load of 15,000 h.p. absorbed by the Union Carbide Company, and the remainder was occupied with the miscellaneous customers, including the various electro-chemical and metallurgical works in the vicinity.

Mr. Woodbridge gives much space to a description of the apparatus installed for delivering 15,000 h.p. to the Carbide Company, this involving transformers with an aggregate capacity of 50,000 h.p. This was found necessary because of the desirability of stepping-up the voltage at the power-house instead of transmitting at the generator pressure of 2,200 volts.

In referring to the transmission line to Buffalo, the most important change which has been made is that of separating the six cables to a greater distance from each other. With the original spacing of 18 inches it was found altogether too easy for mischievously inclined persons to throw pieces of wire, or other metallic substances over the wires, starting arcs and making much trouble at the terminal stations. By introducing lower cross arms a triangular spacing has been arranged, giving a minimum distance of 36 inches between the wires and rendering such malicious mischief much less practicable. The pressure on the line at present is 11,000 volts, but to provide for further increase of loads in Buffalo it is proposed to raise this to 22,000 volts, providing suitable transformers at each end.

Mr. Woodbridge describes in much detail the precautions which have been taken to prevent any interruption to the supply on this long-distance system, and the whole paper is a remarkably complete account of what is at the present time undoubtedly the greatest electrical plant in the world.

American Bridge Builders in Africa.

An interesting sequel to the much-discussed Atbara Bridge affair is found in the presentation of a paper upon the subject of the bridge before the Engineers' Club of Philadelphia, the paper being by Mr. Richard Khuen, Jr., and the discussion including remarks by some of those who superintended construction of the bridge in the works and those who erected it in its place.

Mr. Khuen emphasizes the point that the bridge itself is a comparatively insignificant structure, being a narrow gauge affair of seven spans of 147 feet each, the entire contract representing only 750 tons of material, and its construction would hardly have merited more than a brief notice had it not been for the circumstances which attended the placing of a British government contract with an American firm, both on account of lower price and much shorter time than any British firm would offer.

The paper gives a detailed description of the bridge, similar to the various accounts already published, both in England and America, and furnishes complete detailed drawings and strain sheets, giving the plans and computations which were made for this especial structure, showing conclusively that the whole bridge was designed and constructed subsequently to the receipt of the order, and effectually disposing of the idea that any portion of it was in stock at that time.

The contract undertook to deliver the completed bridge to the vessel in New York in 42 days, the actual time was 40 days, and the time occupied in the construction was 29 working days, making deduction for seven days lost during the great snow storm when the works was closed, and the four Sundays on which no work was done. While this may seem rapid work, Mr. Khuen calls attention to the fact that the capacity of the Pencoyd Works is from 5,000 to 6,000 net tons per month, so that this little contract of 750 tons practically represents only about four days' work for the entire shop.

Apart from the general English criticisms of the design because of its pin connections, the author calls attention to the fact that criticisms in *Engineering* and in *Stahl und Eisen* are based on typographical errors in the published descriptions of the bridge, and even these are unimportant.

"A partial explanation of the difference between the time the British manufacturers specified in their bids for this comparatively small contract and that specified by the Pencoyd Iron Works and other American bidders lies in the standardizing of structural shapes and in the improved machinery in use in the United States. Another explanation lies in the fact that an American bridge designer studies all designs with a view to duplication of parts to reduce templet work, and tries to make the shop work as uniform as possible and in accordance with an established standard. He also confines himself to standard shapes, and can therefore rely on receiving his material at once.

"A British designer prides himself on his originality, and attempts to stamp his individuality on his work; consequently there is no uniformity in shop work. He also uses special shapes, for the same reason, so that new rolls usually have to be made for nearly every contract, entailing considerable loss of time with no compensation in the form of improved work. This applies equally as well to locomotives and other engineering products. The conservative policy of British manufacturers as regards machinery is well known, while American manufacturers are continually discarding the old methods and machinery for more modern."

Some interesting remarks were made by Messrs. Wennas and Wolfel, of the party who went out to the Soudan to assist in the erection of the bridge, the difficulties with Egyptian and Soudanese workmen being told; and it may be of interest to learn that the method of erection, about which there has been some discussion, was planned especially for this case, not having been employed anywhere before so far as the constructors knew, but being derived from the exigencies of the situation.

The American Iron Trade.

THE remarkable developments of the iron trade during the year 1899 render the review of the business in the Pittsburg district, by Mr. Robert A. Walker, in the *Iron Age*, a matter of especial interest at the present time. The year has been the greatest ever known in the iron trade, both in the volume of business and in its profits, and for activity, advances in prices, and records in every department it will probably stand without a parallel for many years to come.

The whole year has been one continuous record of advancing prices, increasing demand, and great profits; and there is every prospect that the present year will show a maintenance of the demand thus created.

As an example of the advance which has been experienced in 1899, we may quote what Mr. Walker says about the advance in pig iron:

"The blast-furnace that cannot show a balance on the right side of the ledger at the close of this year nearly as large as the investment itself, or perhaps larger, has certainly something wrong with its management, or there is something out of order somewhere."

In January, 1899, Bessemer pig iron was selling at $10 to $10.25. By the close of the year the price had risen to $24 per ton! This remarkable advance came gradually and steadily throughout the year, and was by no means speculative, but was caused by the increasing demand for legitimate purposes.

Turning now to the production of steel rails, the tonnage was enormous, the output of the leading mills having been unparalleled. At the beginning of the year the price was about $17 per ton. By the close of 1899, the price had advanced to $35 to $37 per ton at mill. The output of the rail mills for 1899 will certainly be found to have been considerably more than 2,000,000 tons, and the average of prices will undoubtedly show a very handsome profit. The profitable business which has been done by the railroads has put them in the market as purchasers for material for 1900 delivery, and so, notwithstanding the high prices the purchases will doubtless continue to be extensive. A similar heavy demand appeared early in the year for structural material, and during the middle of the year there was a famine in material for three or four months, fabulous prices being paid where sellers were able to promise anything like prompt delivery.

The heaviest advance, however, appeared in plates, the price for tank plates have risen from 1.25 cents in January, 1899, to 3 cents, in July, an advance of $35 a ton. For four or five months in the middle of the year material could hardly be had at any price, and work was delayed all over the country on account of the inability of contractors to get shipments from the mills. In spite of enormous increase in capacity, due to the building of new mills by some companies and enlargements by others, it was not until October that the mills began to catch up with their orders. Much of this demand for plates has been caused by the large consumption of the Pressed Steel Car Company, which is using from 1,000 to 1,500 tons per day in the manufacture of steel cars; the greater portion of this tonnage being furnished on a ten-year agreement by the Carnegie Steel Company.

Taking a general view of this phenomenal rise, and considering that it was undoubtedly due to a legitimate demand for actual consumption, it becomes possible to predict, with a fair degree of accuracy, the prospects for the year 1900. There is little fear that the rise in prices will lessen the demand for iron and steel finished products. The prices have not risen sufficiently to cause this to be the case, and when the amount of work which has been postponed is considered, it will be seen that there is ample demand to insure a constant market during the present year. There is a vast amount of work which must be done, and the material for it must be got somehow, and under such circumstances the market will surely be sustained.

All this takes into account only the home market, but there is a foreign market to be considered. During the past year America made 40 per cent. of the world's iron. This proportion is on the increase, and will doubtless continue so, in view of the great natural resources of the country, because of its superior plant, and because of its active and intelligent labor. In the one item of electric tramways alone, the development in Europe is scarcely begun, and the demand for rails, trolley poles and material must be largely supplied from America.

The Regulation of Gas Engines.

A FEATURE in the modern internal combustion motor, which is sometimes made what is called a "talking point," is that of the method of regulation of speed, and a communication from Mr. W. H. Booth in a recent issue of the *American Machinist* brings out some interesting features of this detail.

The methods of governing may be broadly divided into two classes, one being the "hit-and-miss" method, and the other the method of regulated charges. The hit-and-miss plan originated with the old Otto and Langen explosion engine, in which the action took place by exploding a charge of gas and air under a free piston, which was thus shot up into the air, and then drawn down by the action of the vacuum formed in the cylinder. Obviously there was no other method of governing such an engine, and it was rather curious to observe the intermittent manner in which this free piston would shoot up at all sorts of irregular intervals, as the variations in the load demanded. The so-called Otto "silent" engine, which was the immediate successor of the Otto and Langen, being made by the same builders, was naturally provided with the same method of governing, and thus, by a sort of mechanical heredity, the hit-and-miss method came into very general use.

Various detailed methods have been devised to carry out this plan of governing, some engines being fitted with centrifugal governors which throw the valve gear in or out of action as the speed falls or rises, while others are provided with a pendulum gear having a rate of vibration dependent upon its length and permitting the valve gear to operate only when the reciprocations of the engine fall below the rate of vibration of the pendulum.

Of the superior economy of this method of governing there is no doubt. When the speed is maintained no consumption of gas takes place whatever, and when the speed falls only so much gas is used as is absolutely necessary to restore the rate. With such an expensive fuel as illuminating gas this economy was practically essential, and even under such circumstance the gas engine only came into use extensively for such work as demanded intermittent loads and in which the advantages of convenience were of more importance than actual economy of fuel.

The method of regulating the mixture of air and gas in the charge has undoubted advantages, so far as superiority of regulation is concerned, and with the present requirements of such motors, especially for driving electric generators, this is a matter of much importance. It is evident that the motion of an engine which makes only one power stroke in every four cannot be as uniform as that of a steam engine, and when to this lack of uniform impulse is added the omission of power-strokes as a means of checking speed it is apparent that noticeable fluctuations must occur.

Mr. Booth points out very clearly that at the present time the question of gas-engine economy stands on a different basis from that existing when it was first introduced on the market, and that the use of cheap producer-gas or of the waste gases of blast furnaces renders it no longer necessary to measure out the number of charges with that careful economy obtaining when such a choice commodity as illuminating gas is the fuel.

"Producer gas is so cheap that it has enabled gas engines to be more employed, and the cost of power thus produced has been found to be so small that the advantage of the hit-and-miss method of governing has lost its chief point of advantage, for the money cost of the more regular control of regulated charges is so very small as to afford the advantages of regular rotation."

Mr. Booth takes occasion again to emphasize the great waste of power which is permitted by the non-utilization of blast-furnace gases.

"It is surprising to see how very slowly people wake up to the idea of using blast-furnace gas, which is so cheap and plentiful that if anyone undertakes to use the output of a single furnace he will need to put down about the biggest installation of gas engines yet going.

"In California they will spend thousands of dollars in building headworks, dams, tunnels, and pipe-lines to utilize distant water-powers, whereas the cost of utilizing waste gas is very much less. It is almost as if everything in a water-power scheme were to be given free except the turbines. There is very little doubt that in a few years we shall see a large amount of electricity generated by gas power from gases now practically wasted."

This question of the character of the gas used upon the method of governing to be employed is a point well made, and the time is doubtless at hand when the design of a gas motor will be made to depend largely upon the character of the fuel with which it is to be worked.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Ceilings.

Ceilings. L. A. Shuffrey. Resumé of a paper read before the Liverpool Arch't Soc. Reviews the progress, illustrating famous ceilings in England from the time of Henry VIII. 2500 w. Builder—Dec. 16, 1899. No. 31610 A.

Steel Furring for Ornamental Ceilings. Illustrates and describes the methods employed to produce the effect of gothic masonry ceilings by light concrete-steel construction. 800 w. Eng Rec—Dec. 23, 1899. No. 31481.

Exposition.

The U. S. Machinery Building at the Paris Exposition. Illustrated description of the building designed to furnish a true idea of an American shop. 1100 w. Eng Rec—Dec. 16, 1899. No. 31471.

Foundations.

Foundations of Buildings. S. Anglin. Read before the Manchester, Eng., Soc. of Archts. On the superstructure or foundations of buildings in general, and of steel skeleton construction in particular. 4200 w. Jour Roy Inst of Brit Archts—Nov. 11, 1899. No. 31321 D.

The Foundations of a Large Power House. Describes the methods of putting in a thick spread concrete base under the 70,000 H. P. station of the 3d Ave. Ry. Co., New York. 1200 w. Eng Rec—Dec. 16, 1899. No. 31473.

Mural Painting.

Mural Painting in Its Relation to Architecture. Elmer E. Garnsey. Read before the Am. Inst. of Architects. On the value and treatment of color. 4000 w. Am Arch't—Dec. 2, 1899. No. 31183.

Roof.

The Forty-Seventh Regiment Armory Roof, Brooklyn. Illustrated description of the design and erection of a steel roof framework with a transverse span of nearly 200 ft. and a rise of 84 ft. 1200 w. Eng Rec—Dec. 23, 1899. No. 31483.

Skeleton Structures.

The Legitimate Design of the Architectural Casing for Steel Skeleton Structures. C. H. Blackall. Read before the Am. Inst. of Archts. Considers the designs most generally accepted and discusses some absurdities. 2800 w. Am Archt—Dec. 2. 1899. No. 31184.

HEATING AND VENTILATION.

Hot Water.

Overhead Hot Water Heating System in Masonic Temple Building. Illustrated description of the system adopted at this large building in Staunton, Va. 1200 w. Met Work—Dec. 16, 1899. No. 31392.

The Calculations for Pipes for Hot Water Heating (Berechnung von Rohrleitungen für Warmwasserheizungen). H. Weiprecht. Deriving a formula for use in practice, and giving examples of computations. 1800 w. Gesundheits-Ingenieur—Nov. 30, 1899. No. 31584 B.

Residence.

Ventilation and Heating of a Large New York Residence. Illustrated description of the plant in the W. D. Sloane mansion, which includes both indirect heating and a modified hot-blast system. 3300 w. Eng Rec—Dec. 23, 1899. No. 31484.

Steam Heating.

A Low-Pressure Gravity Heating Apparatus in a School House. Illustrated description of a one-pipe steam heating system with gravity return, in a Milwaukee high school. 1800 w. Eng Rec —Dec. 16, 1899. No. 31472.

Good and Bad Practice in Steam Heating. W. H. Wakeman. Discusses some points in the heating with exhaust steam. 900 w. Am Mach—Dec. 21, 1899.. No. 31432.

PLUMBING AND GAS FITTING.

Sanitation.

Plumbing and Household Sanitation. J. Pickering Putnam. On the importance and the architect's responsibility, the neglect, and sources of danger. Ill. 7000 w. Dom Engng—Dec., 1899. No. 31624 C.

MISCELLANY.

Address.

Presidential Address before the Royal Institute of British Architects. William Emerson. Historical review of progress during the past century. Also discussion. 9500 w. Jour Roy Inst of Brit Archts—Nov. 11, 1899. No. 31320 D.

Building Stones.

Building Stones and Stone Cutting. Alexander Marshall. Read before the Toronto Chapter Ontario Assn. of Archts. Gives information relating to the strength and durability of various stones, and the care needed in cutting. 2700 w. Can Archt—Dec., 1899. No. 31486 C.

We supply copies of these articles. See introductory.

Exposition.

The Palaces of Foreign Nations at the Paris Exposition. Illustrations of a number of these buildings. 900 w. Ir Age—Dec. 7, 1899. No. 31264.

Fireproofing.

See Civil Engineering, Miscellany.

Metal.

Expanded Metal. J. P. Allen. Read at meeting of the Northern Arch't Assn., England. Describes this material, and discusses its uses to the building trades. 5500 w. Archt, Lond—Dec. 16, 1899. No. 31611 A.

CIVIL ENGINEERING

BRIDGES.

Arches.

The Three-Hinged Arch. Considers the origin of hinged arches, and the applications to which the three-hinged arch is adapted, with other information. 2000 w. Engr, Lond—Dec. 1, 1899. No. 31344 A.

Bridges and Tunnels.

Proposed Plans for Bridges and Tunnels Across the East River at New York City. Discusses the plans for improving the transit facilities. Also editorial discussion. 3000 w. Eng News—Dec. 28, 1899. No. 31644.

The Relative Advantages of Bridges and Tunnels. Discusses the advisability of driving tunnels for communication between two large communities for which long-span bridges offer the only alternative connection. Also report on the use of tunnels between Brooklyn and Manhattan, New York, by W. B. Parsons. 2800 w. Eng Rec—Dec. 16, 1899. No. 31465.

Design.

The Artistic Side of Bridge Design. A reply to an editorial in the *N. Y. Times*, condemning the American engineer for his lack of artistic feeling. Ill. 900 w. Eng News—Dec. 21, 1899. No. 31462.

Drawbridges.

An Electric Drawbridge at Boston. W. S. Key. Illustrated description of a new bridge across the Charles River, the draw being operated by means of two G. E. "58" railway motors of 28 h. p. capacity each. 1600 w. Elec Wld & Engr—Dec. 23, 1899. No. 31602.

Experimental Determination of Draw-Bridge Reactions. Malverd A. Howe. An account of investigations made to determine a reliable method for computing these reactions. 2000 w. Eng News—Nov. 30, 1899. No. 31155.

East River.

The New East River Bridge. Extracts from the address of O. F. Nichols before the Broadway Merchants' Association of Brooklyn. Ill. 1800 w. R R Gaz—Dec. 15, 1899. No. 31373.

Highway Bridge.

Highway Bridge at Nogent-sur-Marne (Pont Route de Nogent-sur-Marne). A. Dumas. Illustrated description of a handsome cast-iron arch bridge across the Marne, with details of the piers and abutments. 2500 w. 1 plate. Génie Civil—Dec. 9, 1899. No. 31506 D.

Japan.

American Bridges in Japan. Illustrated description of two bridges containing a number of special features made necessary by the requirements of the transportation facilities. 1000 w. Eng Rec—Dec. 23, 1899. No. 31479.

Joints.

Flexible Joints (Joints Flexibles). A discussion of the methods of M. Mesnager for providing flexibility in members of trussed structures in order to avoid non-axial stresses. 1500 w. Revue Technique—Dec. 10, 1899. No. 31517 D.

Piers.

The New Cornwall Bridge Piers. Illustrated description of the difficult work of tearing down and rebuilding large concrete and limestone piers which were originally founded on unstable bottom. 5000 w. Eng Rec—Dec. 9, 1899. No. 31301.

Suspension.

Comparison of Suspension Cable Specifications of Brooklyn and New East River Bridges. Editorial comparison of the leading features of the two structures. 2200 w. Eng News—Nov. 30, 1899. No. 31157.

Temporary Work.

The Temporary Restoration of Railway Bridges. An account, with illustrations, of the type of structure and methods of operation for rapid construction. Part first considers wooden bridges. 3200 w. Engng—Nov. 24, 1899. Serial. 1st part. No. 31205 A.

Tunis.

Trolley Bridge at Bizerta, Tunis. Illustrates and describes what is known in France as the "transbordeur" type of bridge of the Arnodin's system. 1500 w. Ry & Engng Rev—Dec. 2, 1899. No. 31200.

Viaducts.

Viaduct Alterations Without the Use of Falsework. F. S. Edinger. Reported at the meeting of the Assn. of Ry. Supts. of Bridges and Buildings. Describes repairs without falsework to a structure 117 ft. high and 440 ft. long, without delay of trains. 1400 w. Ry & Engng Rev—Dec. 9, 1899. No. 31311.

CONSTRUCTION.

Caissons.

Caisson for the Intake Pier for the Cincinnati Water-Works. Illustrated description of the 58 x 30 ft. caisson for a heavy masonry pier considerably over 100 ft. high. 500 w. Eng Rec—Dec. 9, 1899. No. 31300.

Colombo.

Old and New Colombo. John Ferguson. Gives the history, industries, minerals, gems, etc.; describes the railways, harbor works, sanitation, and other matters of interest in this capital city of Ceylon. Discussion. 16500 w. Jour Soc of Arts—Dec. 15, 1899. No. 31499 A.

Concrete Docks.

Concrete Docks for the Illinois Steel Co., at South Chicago, Illinois. Describes the conditions which made necessary reconstruction, and gives an illustrated description of the type adopted. 1700 w. Eng News—Dec. 14, 1899. No. 31365.

Concrete Docks of the South Works of the Illinois Steel Company. Illustrations showing the details of construction, with brief description. 1200 w. Ir Age—Dec. 14, 1899. No. 31341.

Cribs.

Cost of Crib Construction—Brief Methods for Preparing Estimates. G. A. M. Liljencrantz. Explains the plan of the writer for obtaining a reasonably accurate estimate in a short time. Describes four different methods, each in turn giving a closer approximation to accuracy than the preceding. 4000 w. Jour W. Soc of Engs—Oct., 1899. No. 31303 D.

Dikes.

The Construction of Earthen Dikes (Construction des Digues en Terre). A. Dumas. A description of the so-called English method, in which a central puddle-wall of clay is used to insure resistance to leakage. 2000 w. Génie Civil—Dec. 2, 1899. No. 31505 D.

Dredges.

Steam Tenders and Dredges on the Mississippi River. Illustrated description of one of the five large tenders under construction. 1500 w. Eng News—Dec. 7, 1899. No. 31289.

Excavator.

Lowrie's Power Excavator. Illustrated description of a new design containing novel features. 1300 w. R R Gaz—Dec. 8, 1899. No. 31293.

Foundations.

See Architectural Engineering, Construction.

Simplon Tunnel.

A New Tunnel Over the Alps. Information relating to the progress of work on this railway tunnel. 800 w. Loc Engng—Dec., 1899. No. 31144 C.

HYDRAULIC AND MARINE.

Aqueduct.

Completing the Abandoned Aqueduct Tunnel at Washington, D. C. Gives a brief statement of the original work on this tunnel, which was abandoned ten years ago, and an illustrated description of the methods employed to complete the work. 18000 w. Eng News—Dec. 28, 1899. No. 31641.

Canals.

Internal Navigation in France in 1898 (La Navigation Intérieure de la France en 1898). A discussion of the official figures, which show an increase of 4.8 per cent. in ton-kilometres over the preceding year. 1000 w. Moniteur Industriel—Nov. 25, 1899. No. 31569 F.

Report of the Special Commission on the Chicago Drainage Canal. An abstract of the report of the special commission appointed to see if the work was executed in accordance with the law, and of the reply of the Trustees who dispute some points. 4500 w. Eng News—Dec. 7, 1899. No. 31286.

The Effects of the Manchester Ship Canal. Abstract of paper by A. Woodroofe Fletcher. Credits the canal with causing the great revival in trade and general prosperity. 2500 w. Engr, Lond—Dec. 8, 1899. No. 31421 A.

The Rhine-Elbe Canal and the Railways of the Ruhr District (Der Rhein-Elbe-Kanal und die Eisenbahen des Ruhrbezirks). A discussion of the question of the capacity of the railways to handle the traffic of the district, and of the necessity for the proposed canal. 4000 w. Glückauf—Nov. 18, 1899. No. 31540 B.

Dams.

Earth Backing for Masonry Dams. E. S. Gould. A theoretical demonstration that an earth-fill behind a masonry dam diminishes the pressure coming on it. 1000 w. Eng Rec—Dec. 23, 1899. No. 31482.

Distribution.

Some Notes on the Design of Water-Works Distribution Systems. Gardner S. Williams. Considers the essentials of this question. Also discussion. 7500 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31378 E.

Drainage.

Hints on Farm Drainage. The Proper Methods and Results of Draining Land. Anton Vogt. Discusses tile drainage and results, with suggestions for laying the tile, etc. 5000 w. Brick—Dec. 1, 1899. Serial. 1st part. No. 31270.

The Drainage of Poona. A statement of the existing conditions, and the need of promptly rectifying the sanitary defects. 2500 w. Ind & East Engr—Nov., 1899. No. 31387 D.

Flood-Water.

Flood-Water Channel of the Altoona, Pa., Reservoirs. Charles W. Knight. Illustrated detailed description of a channel built to keep out acccumulations brought down the valleys by the floods. 2000 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31382 E.

Flow.

Pini's Apparatus for Measuring the Velocity of Flowing Water (Ueber Sante Pini's Apparate für Geschwindigkeits messungen in Fliessenden Wasser). V. Pollack. Describing a modification of the Pitot tube which gives good results in measuring the velocity of currents. Two articles, 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 17, 24, 1899. No. 31-526 each B.

The Flow of Water in Pipes. C. H. Tutton. An attempt to show that the Torricellian formula, $v^2 = 2\,gh$, is misapplied in the fundamental stages of the science of hydraulics. 13 plates. 5700 w. Jour Assn of Engng Socs—Oct., 1899. No. 31125 C.

The Measurement of the Velocity of Flow of Streams (Ueber Messungen der Bewegungs-Geschwindigkeiten von Flussläufen). Paul Fuchs. A description of the Schultze apparatus by which information as to the flow and level of streams can be electrically communicated to a distance. 2500 w. Gesundheits-Ingenieur—Nov. 30, 1899. No. 31583 B.

Ground Water.

Principles and Conditions of the Movements of Ground Water. Extract from 19th Annual Report of the U. S. Geol. Surv. Investigations made by F. H. King and C. S. Slichter. 2800 w. Eng News—Dec. 28, 1899. No. 31646.

The Law Relating to Underground Water. Lecture by Robert Cecil. Explains the historical development of the English law relating to percolating water. 6000 w. Jour Gas Lgt—Nov. 7, 1899. No. 31164 A.

Harbor Works.

Notes from Japan. Gives illustrations and descriptions of the Otaru harbor works. 2800 w. Engng—Dec. 15, 1899. No. 31617 A.

Hydrants.

The Care of Fire Hydrants in Winter. George I. Bailey. Considers methods for their care and maintenance. 2000 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31379 E.

Level Indicator.

Long-Distance Water-Level Indicator (Wasserstands-Fernmelde-Apparat). A description of the Siedek-Schäffler apparatus, by which the level of any body of water may be ascertained at a distant station. The indications of a float-device are electrically transmitted. 6000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1899. No. 31531 D.

Light-houses.

Lighthouse Engineering at Home and Abroad. J. A. Purves. Abstract of a paper read before the Inst. of Engs. and Shipbuilders in Scotland. An illustrated historical review. 6000 w. Engs' Gaz—Dec., 1899. No 31327 A.

Pipe Coatings.

Coatings for Cast-Iron Water-Pipes. Thomas H. Wiggin. Extract from a paper on "The Manufacture and Inspection of Cast-Iron Pipes," read before the Boston Society of Civil Engineers. Gives the results of the writer's study and experiments. 6200 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31236 H.

Pumping Engines.

See Mechanical Engineering, Hydraulic.

Reservoirs.

A Concrete-Asphalt Reservoir Lining. Describes the lining of a basin having a capacity of 15,600,000 gallons, at Whitby, Eng., with two layers of concrete with asphalted canvas between them. 1600 w. Eng Rec—Dec. 16, 1899. No. 31470.

River Discharge.

Discharge Measurement of the Niagara River, at Buffalo, N. Y. An outline of the work performed, with some general conclusions. 900 w. Eng News—Dec. 28, 1899. No. 31643.

River Improvement.

The Regulation of the Wottawa at Strakonitz, Bohemia (Die Regulierung der Wottawa bei Strakonitz). F. Stupecky. A report upon the regulation of a feeder of the Moldau, showing how the flooding of the surrounding country was prevented by providing a permanent channel. 5000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1899. No. 31530 D.

Standpipes.

Standpipes. Byron I. Cook. Describes the construction of several. Also discussion. 3500 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31380 E.

Water Filters.

Ice Elevator at the Lawrence Filter Beds. Illustrated description of the elevating machine, something like a ladder dredge, used to take the ice from the open sand filters. 500 w. Eng Rec—Dec. 9, 1899. No. 31302.

The Regulation of the Albany Filters. An explanation of the methods adopted at this plant to combine the advantages of both the British and German methods of operating slow-sand filters. 900 w. Eng Rec—Dec. 9, 1899. No. 31299.

Water Meters.

A Meter-Testing Apparatus. Emil L. Nuebling. Illustrates and describes the plant of the Reading, Pa., Water Dept. 700 w. Eng Rec—Dec. 23, 1899. No. 31477.

Water Rates.

Methods of Assessment and Collection of Water Rates. F. H. Crandall. Discusses various methods. General discussion. 9500 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31381 E.

Water Supply.

The Water-Works of Media, Pa. Illustrated description of a plant containing a number of novel features for the regulation of the supply for high and low service districts, with the results of a test of the pumping plant. 1800 w. Eng Rec—Dec. 2, 1899. No. 31192.

Water Supply and Purification Works at Parkville and Bethany, Mo. Wynkoop Kiersted. Illustrates and describes the sedimentation and mechanical filtration plant at Parkville, Mo., and the new intake crib, siphon, filter bed and clean water well at Bethany, Mo. 1600 w. Eng News—Dec. 14, 1899. No. 31368.

MATERIALS.

Beams.

Compound Beams (Zusammengesetzte Träger). A. Schneider. A mathematical discussion of the strength of built-up timber beams, with tables for various loadings and examinations of special cases. Three articles, 12000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 24, Dec. 1, 9, 1899. No. 31527 each B.

Bricks.

Brick Testing in 1895-1897 (Ziegelprüfungen in den Betriebsjahren 1895-1897). M. Gary. A very full review and record of the tests made at the Royal Testing Laboratory at Charlottenburg, with tabulated details and curves of results. 15000 w. Mitt aus den Kgl Tech Versuchsanstalt—Part IV., 1899. No. 31578 G.

The Resistance of Brick Masonry (Die Tragfahigkeit von Ziegel-Mauerwerk). F. von Emperger. A review of recent English and American experiments, with illustrations of many tests. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 1, 1899. No. 31528 B.

Cement.

Cement Tests for Municipal Works. Discusses the advantages of testing cement for different cities in a state laboratory. 1400 w. Eng Rec—Dec. 16, 1899. No. 31466.

Economies of Cement Mortar. Ira O. Baker. Considers methods of proportioning the mortar, tensile strength, cost, etc. 2200 w. Br Build—Dec., 1899. No. 31623 C.

The Works of the Nazareth Portland Cement Company. Illustrated description of a 1000-bbl. plant containing considerable special machinery, including a new type of rotary dryer using powdered coal as fuel. 2000 w. Eng Rec—Dec. 16, 1899. No. 31467.

Concrete.

A Complete Mixer Plant. Illustrated description of the plant used to mix concrete for gun emplacements at a place where labor was difficult to obtain and the machinery had to be as nearly automatic as possible. 1400 w. Eng Rec—Dec. 2, 1899. No. 31193.

The Theory and Practice of Concrete. Discussion of the features of concrete making which are still matters of dispute. 1200 w. Eng Rec—Dec. 23, 1899. No. 31474.

Fireproofing.

A Wood Fireproofing Plant. Illustrated description of a plant for injecting a fireproofing liquid into wood, with a statement of the results of the process. 1700 w. Eng Rec—Dec. 2, 1899. No. 31194.

Fire-Proof Wood for Ships. Illustrates and describes one of the plants and the process of manufacture. 2000 w. Marine Rev—Nov. 30, 1899. No. 31121.

Piles.

Worm Eaten Piles. Onward Bates. A report of investigations made, and of the writer's experience with southern timber. 1500 w. Jour W Soc of Engs—Oct., 1899. No. 31305 D.

Pillars.

The Resistance of Built-Up Stone Pillars to Buckling (Zur Berechnung der Knickfestigkeit Gegliederter Steinpfeiler). Deriving a general formula for practical use in proportioning stone pillars, and showing the application of the method by examples. 1200 w. Deutsche Bauzeitung—Nov. 25, 1899. No. 31571 B.

Structural Iron.

The Permissible Stresses Upon Structural Iron (Die Zulässigen Inanspruchnahmen des Eisens in Hochbau). F. von Emperger. A mathematical discussion of the relative proportions of beams, columns, girders, etc., in modern building construction. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 2, 1899. No. 31524 D.

Timber.

The Present Status of the Study of Timber (Der Heutige Stand der Holzuntersuchungen). M. Rudeloff. A discussion of the present methods of testing timber, with suggestions as to the international unification of testing methods. 7500 w. Mitt aus den Kgl Tech Versuchsanstalt—Part IV., 1899. No. 31-579 G.

MUNICIPAL.

Compensation.

Extra Work of City Surveyors. Reviews a decision of the Wisconsin Supreme Court that the city surveyor of Madison should be paid an extra fee outside his salary for any sewer work he designed. 900 w. Eng Rec—Dec. 2, 1899. No. 31189.

Glasgow.

Cities and Public Works. The Correct Story of Glasgow's Achievements. Robert Watt. Compares the conditions of Glasgow and San Francisco, and favors private control. 2400 w. Am Gas Lgt Jour—Dec. 4, 1899. No. 31185.

Parks.

The Park Systems of Boston and Vicinity. A statement of the radically different plans followed by the city and state commissions. 900 w. Eng Rec—Dec. 2, 1899. No. 31191.

Paving.

Maintenance of Asphalt Streets in Cincinnati, O. Describes particularly the methods of repairing street openings and keeping pavements in repair along tracks. 1000 w. Eng Rec—Dec. 2, 1899. No. 31197.

Notes on Brick Pavements. An account of the practice in Buffalo, Cleveland, Cincinnati, Louisville, Kansas City, Omaha, St. Louis, Detroit, Philadelphia, and Providence. 1700 w. Eng Rec—Dec. 23, 1899. No. 31480.

Street Paving in Michigan. A summary of the work done in 1898, with costs and methods. 1200 w. Eng Rec—Dec. 2, 1899. No. 31195.

Refuse.

The Next Step in the Work of Refuse and Garbage Disposal. W. F. Morse. Read at meeting of the Am. Pub. Health Assn., at Minneapolis. Reviews the progress recently made, and the points where improvements are needed, giving an account of works at Boston and in English cities. 10500 w. San—Dec., 1899. No. 31169 D.

Notes on the Operation of the Montreal Garbage Furnace. Notes on the operation of a furnace built on English lines which claims to burn the garbage with practically no expense for fuel. 1100 w. Eng News—Dec. 7, 1899. No. 31288.

Sewage.

Chemical Precipitation and Rapid Filtration of Sewage at Madison, Wis. Outlines the history of sewage disposal in this city and gives an illustrated description of the new plant in operation since June, with objections raised and alleged defects. 4400 w. Eng News—Dec. 28, 1899. No. 31642.

Diversion and Purification of the Sewage of Paris. An account of this scheme and its practical realization, which marks the progress of sanitary science in France. 2800 w. Engr, Lond—Nov. 24, 1899. No. 31212 A.

Experiments on Sewage Purification at the Lawrence Experiment Station During 1898. From the report of the Massachusetts State Board of Health, outlining the work. 2000 w. Eng News—Dec. 21, 1899. No. 31461.

Manchester Sewage. Editorial on the changes in disposal made necessary by the construction of the ship canal, and the experiments made. 3000 w. Engng—Dec. 1, 1899. No. 31331 A.

Manchester Sewage. Report of investigations made by three experts is outlined and some points discussed. 3000 w. Engr, Lond—Nov. 24, 1899. No. 31213 A.

Recent Lawrence Experiments in Sewage Disposal. A review of the investigations of the Massachusetts Board of Health in 1898, with septic tank and bacteria bed methods of disposal. 3200 w. Eng Rec—Dec. 23, 1899. No. 31476.

Sewage Disposal at Lincoln, England. James H. Fuertes. Illustrated explanation of the works for chemical treatment with ferozone, filtration of the sewage thus dosed through polarite beds, and the use of the effluent for irrigation. 1100 w. Eng Rec—Dec. 23, 1899. No. 31478.

Sewage Disposal at Manchester, England. James H. Fuertes. Illustrated description of the chemical treatment works in use in 1899. and a brief description of the experiments to find some more satisfactory system. 1400 w. Eng Rec—Dec. 2, 1899. No. 31196.

The Septic Tank at Overbrook, N. J. Describes a small system and gives the results attained in its use. 1200 w. Eng Rec—Dec. 16, 1899. No. 31468.

Sewers.

A Large Overflow Chamber. Illustrated description of an overflow on a sewer 14¾ ft. in diameter, at Cleveland, O. 1200 w. Eng Rec—Dec. 16, 1899. No. 31469.

Streets.

The Financial Loss Caused by Narrow Streets. Reviews some figures recently given by J. W. Barry, of the delay in traffic on four London streets due to congestion. 800 w. Eng Rec—Dec. 2, 1899. No. 31190.

MISCELLANY.

Address.

Presidential Address before the Institution of Civil Engineers. Sir Douglas Fox. Condensed address of more than usual interest, touching upon many branches of engineering. 4700 w. Eng News—Nov. 30, 1899. No. 31158.

Education

Some Unrecognized Functions of Our State Universities. J. R. Johnson. Full address on the occasion of inauguration as Dean of the College of Mechanics and Engineering of the Univ. of Wisconsin. 6000 w. Jour W. Soc of Engs—Oct., 1899. No. 31304 D.

Technical Education in Germany. Extract from address of Jas. Loudon, at the Univ. of Toronto. 1500 w. Eng News—Nov. 30, 1899. No. 31156.

Engineering Work.

The Great Lakes. John Birkinbine. An account of the magnitude and diversity of the engineering work in this region. 5400 w. Jour of Worcester Poly Inst—Nov., 1899. No. 31127 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Fire-Alarm.

A Modern Fire-Alarm System. Illustrated description of the protective equipment of the Washington Life Insurance Building, New York City. 1000 w. Elec Rev, N. Y.—Dec. 20, 1899. No. 31447.

South Africa.

News from South Africa. Explaining how the war news from Natal reaches New York. 700 w. Elec Rev, N. Y.—Nov. 29, 1899. No. 31136.

Space Telegraphy.

A Non-Technical Account of Wireless Telegraphy. Brief review of discoveries made and explanation of the principles. 2000 w. Min & Sci Pr—Dec. 2, 1899. No. 31263.

The Guarini Relay System (Relais Sistema Guarini). A description of the Guarini relay, by means of which the space covered by the Marconi apparatus may be greatly increased. The action of the coherer operates a fresh transmitter. 2500 w. L'Elettricità—Nov. 25, 1899. No. 31566 B.

The Invention of the Coherer. Camillo Olivetti. The object of the article is to show the real inventor to be Dr. Temistocle Calzecchi Onesti. Ill. 1000 w. Elec Wld & Engr—Dec. 2, 1899. No. 31174.

Telegraphs.

Uganda State Railway Telegraphs. Brief description of the materials used and the lines constructed. 2000 w. Elec Rev, Lond—Nov. 24, 1899. No. 31225 A.

The True Inventor of the Telegraph. Heileman Wilson. Claims the inventor was the writer of an article published in The *Scots Magazine*, Glasgow, 1753, signed C. M. 1000 w. Sci Am—Dec. 30, 1899. No. 31625.

The Zerograph. Illustrated description of this improved instrument—an office type-printing telegraph. 1300 w. Elect'n, Lond—Nov. 24, 1899. No. 31226 A.

Telephone Building.

The New Telephone Establishment at Vienna (Die Neue Telephonanlage in Wien). K. B. von Wehrenalp. With interior and exterior views and plans of the new building, showing the completeness of its arrangements. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 8, 1899. No. 31529 B.

Telephone Exchange.

Power Plants in Modern Telephone Exchanges. H. P. Clausen. Discusses the requirements of a plant, and the construction. Ill. 2000 w. Elec Engng & Tel Mag—Dec., 1899. No. 31487.

The New Common Battery Bell Telephone Exchange, Brooklyn, N. Y. Illustrated detailed description of the latest

Bell practice, with map showing the distribution of exchanges in Brooklyn. 3200 w. Elec Wld & Engr—Dec. 23, 1899. No. 31600.

Telephones.

Largest Telephone System in the World. On the development of the use of the telephone in the city of New York, and the reduction in rates. 1300 w. Elec Rev, N. Y.—Dec. 27, 1899. No. 31634.

The Copenhagen "Automatic" Telephone Call-Boxes. Illustrated description of telephones on the "penny-in-the-slot" principle. 400 w. Elect'n, Lond—Dec. 1, 1899. No. 31324 A.

Telephone Systems.

The Merits of Independent and Industrial Telephone Systems. Kempster B. Miller. Reviewing the progress made since the expiration of the fundamental patents, especially in the introduction of private systems in mines, workshops, and other industrial establishments. 3500 w. Engineering Magazine—Jan., 1900. No. 31589 B.

DISTRIBUTION.

Alternating Currents.

Alternating Current Diagrams. Robert A. Philip. An illustrated explanation of a system of diagrams intended to represent graphically the relations between the various elements of an alternating current circuit. 3000 w. Elec Wld & Engr—Dec. 23, 1899. No. 31603.

Belgium.

The Future of the Distribution of Electric Energy in Belgium (L'Avenir des Distributions d'Energie Electrique en Belgique). M. Eric Gerard. A comparison of the possibility of the competition of steam with water-power in generating electricity, and a suggestion as to the use of blast furnace gases for power. 2000 w. Moniteur Industriel—Nov. 18, 1899. No. 31568 F.

Circuit Breakers.

Electrical Circuit Breakers. William Baxter, Jr. Explains the principle of circuit breakers and gives an illustrated description of various types. 1500 w. Am Mach—Nov. 30, 1899. Serial. 1st part. No. 31140.

Cut-Outs.

Design of Fusible Cut-Outs. B. H. Glover. A statement of facts bearing upon the proper design. 2000 w. W Elect'n—Dec. 2, 1899. No. 31175.

Network.

The Determination of the Best Number of Feeding Points for a Distribution Network (Bestimmung der Günstigsten Zahl von Speispunkten eines Vertheilungsnetzes). A. Sengel. A mathematical investigation, showing the most economical system to be that based on a number of equilateral triangles. Two articles, 7500 w. Elektrotech Zeitschr —Nov. 16, 23, 1899. No. 31549 each B.

Switches.

Methods of Suppressing Arcs in Switches, Fuses, etc. Ernest Kilburn Scott. Read before the Northern Soc. of Elec. Engs., England. Discusses some of the devices to suppress the arc. Ill. 2200 w. Elec Eng, Lond—Dec. 8, 1899. Serial. 1st part. No. 31394 A.

ELECTRO-CHEMISTRY.

Accumulator.

A Study of the Lead Accumulator (Studien am Bleiakkumulator). Martin Mugdan. An exhaustive examination of the chemical and electrical reactions which occur in the lead plate accumulator under various conditions of charging and discharging. 4500 w. Zeitschr f Elektrochemie—Dec. 7, 1899. No. 31561 G.

Electro-Chemistry.

Electro-Chemistry. Wilder D. Bancroft. On the importance of the study, considering points of interest and importance and its applications. 2800 w. Sib Jour of Engng—Dec., 1899. No. 31405 C.

Electrolysis.

The Hargreaves-Bird Electrolytic Alkali Process. John B. C. Kershaw. A consideration of the various reports which have been made upon this process. 1800 w. Elec Rev, Lond—Nov. 24, 1899. No. 31223 A.

The Present State of Industrial Electro-Chemistry (Etat Actuel de la Fabrication des Produits Chimiques par l'Electrolyse). Leon Guillet. An elaborate review of the electrolytic methods of producing the alkalies, chlorates, etc., on a commercial scale. Serial. Part I. 3000 w. Génie Civil—Nov. 25, 1899. No. 31501 D.

Electro-Metallurgy.

Some Notes on the Electro-Deposition of Zinc Under Pressure. Sherard Cowper-Coles. Illustrated description of experiments. 400 w. Elect'n, Lond—Dec. 1, 1899. No. 31325 A.

Electromotive Force.

Chemical Equivalents and Electromotive Force (Chemisches Gleichgewicht und Elektromotorische Kraft). H. Dauneel. A discussion of the theories of van't Hoff and Nernst upon the relation between the chemical equivalents of given substances and the electromotive force produced by their combination. 1500 w. Zeitschr f Elektrochemie—Nov. 23, 1899. No. 31560 G.

Voltaic Cells.

Seat of the E. M. F. in a Voltaic Cell. W. R. Cooper. From a book on "Primary Batteries," to be soon published. States various theories and concludes that it is largely a question of definition. 2300 w. Elect'n, Lond—Dec. 8, 1899. No. 31412 A.

Some Experiments on Voltaic Cells with Compound Electrodes. Frederick S. Spiers. Describes experiments that arose out of an investigation on the action of the zinc which is usually placed in boilers, and supposed to diminish electrolytic corrosion. Ill. 900 w. Elec Rev, Lond—Dec. 8, 1899. Serial. 1st part. No. 31413 A.

ELECTRO-PHYSICS.

Curves.

Deformed Curves (Ueber Deformirte Kurven). Rud. Goldschmidt. A discussion of the variations of alternating-current curves from the strict sinusoidal form, deriving equations for the complicated forms which sometimes occur. 2500 w. Elektrotech Zeitschr—Nov. 30, 1899. No. 31552 B.

The Experimental Plotting of Periodical Occurences in Physical Phenomena (Ueber die Experimentelle Aufzeichnung Periodischer Vorgänge aus Physikalischen Gebieten). Dr. R. Franke. Describing and illustrating apparatus for drawing the curves representing the waves of alternating currents. 4500 w. Elektrotech Zeitschr—Nov. 16, 1899. No. 31548 B.

Potential.

The Difference in Electric Conductors (Ueber einen Auffälligen Werth der Potentialdifferenz auf einem Stromdurchflossenden Leiter). H. Teege. A review of former experiments by Dr. Breisig, showing that the paradox of contradiction of Kirchhoff's law is only apparent. 1800 w. Elektrotech Zeitschr—Dec. 7, 1899. No. 31555 B.

Radiography.

Printing by X Rays (Imprimerie par les Rayons X). L. Le Roux. A general account of the Izambard process for reproducing manuscript or typewriting by use of Röntgen rays. 1200 w. L'Electricien—Dec. 16, 1899. No. 31564 B.

Windings.

Windings for Direct Current Electromagnets. Harold B. Smith. A study of the conditions under which a winding may be designed, with tabulated information. 3000 w. Jour Worcester Poly Inst—Nov., 1899. No. 31129 C.

GENERATING STATIONS.

Alternators.

The Applications of Monophase Alternators (Application des Alternateurs Monophasés). Illustrated description of methods of producing from monophase generators polyphase currents adapted for use with motors. 2500 w. Revue Technique—Dec. 10, 1899. No. 31516 D.

Bonn.

The Electric Plant of the City of Bonn (Das Elektricitätswerk der Stadt Bonn). Dr. Paul Bauer. With plan and section of the buildings, also details of the switchboard and the distribution. 7000 w. Elektrotech Zeitschr—Dec. 7, 1899. No. 31554 B.

Brushes.

Standardizing Carbon Brushes. E. Kilburn Scott. Gives tabulated sizes, suggesting that they be generally adopted, and also information concerning the quality and use. 1000 w. Elec Rev, Lond—Nov. 24, 1899. No. 31224 A.

Burnley.

Burnley Electricity Works. Illustrated detailed description of this English station, including the recent improvements. 3300 w. Elec Eng, Lond—Dec. 1, 1899. Serial. 1st part. No. 31323 A.

Commutators.

Commutator Design and Construction. Alton D. Adams. Discussion, with illustrations of the proper design and construction, and the importance to satisfactory operation. 3000 w. Am Elect'n —Dec., 1899. No. 31282.

Costs.

Influence of Cheap Fuels on the Cost of Electrical Energy. R. E. Crompton. Read before the Inst. of Elec. Engs., England. Discusses the three classes of cheap fuel available in England, and the form of furnace to burn them. Also editorial. 5500 w. Elec Rev, Lond—Dec. 1, 1899. No. 31322 A.

Double-Current Machines.

Transmission Problems for Modern Central Station Supply. The Use of Double-Current Machines. Eustace Thomas. Discusses the systems for a wide area of supply, and the use of the machines named. 1200 w. Elect'n, Lond—Dec. 1, 1899. No. 31326 A.

Electric Supply.

See Street and Electric Tramways.

Generators.

Double Voltage and Current Generators. Alton D. Adams, with editorial. An explanation of the position taken by the writer in a previous paper, which was criticized editorially. 2600 w. Elec Wld & Engr—Dec. 16, 1899. No. 31409.

Hydraulic Plant.

The Power Plant of the Merrill Railway and Lighting Co. F. E. Woodford. Illustrated description of a Wisconsin plant with a combined hydraulic and steam power station. 1000 w. Am Elect'n—Dec., 1899. No. 31281.

Hysteresis.

Hysteresis Loss in Armatures. Ernest Kilburn Scott. Brings up a number of interesting points, which are commented upon editorially. 1800 w. Elect'n, Lond—Dec. 8, 1899. No. 31411 A.

Independent Plants.

Electricity in Modern Buildings. Illustrated description of the various uses to which electricity is put in buildings, and of the apparatus needed to get the best results. 5200 w. Eng Rec—Dec. 2, 1899. No. 31199.

Italy.

Our Hydraulic Power (Le Nostre Forze Idrauliche). A. Raddi. A general review of the question of utilizing the many natural water powers of Italy, discussing the legal, political, and engineering features of the problem. Serial. Part I. 1800 w. Gior d Lav Pub e d Str Ferr—Nov. 8, 1899. No. 31573 B.

The Electric Plant at Salo, on Lake Garda (Impianto Elettrico della Societa Salo Gardone). Illustrated description of an interesting small plant. A head of 127 metres is utilised to drive Pelton wheels operating direct-connected dynamos. 2500 w. L'Industria—Nov. 12, 1899. No. 31572 D.

Municipal Plant.

An Ideal Municipal Electric Plant. Alton D. Adams. Discusses requirements and gives suggestions. 2800 w. Munic Engng—Dec., 1899. No. 31122 C.

The Grand Rapids, Mich., Municipal Central Station. Edward James Hart. Illustrated description. 1000 w. Elec Wld & Engr—Dec. 23, 1899. No. 31604.

Niagara.

Recent Additions in the Power House of the Niagara Falls Hydraulic Power and Manufacturing Company. Illustrated description of special machines for the generation of direct currents for electrochemical purposes from hydraulic power. 2700 w. Am Elect'n—Dec., 1899. No. 31280.

Parallel Driving.

Operating Alternators in Parallel. Describes the usual procedure in coupling. Ill. 1500 w. Power—Dec., 1899. No. 31436 C.

Parallel-Driving with Alternating Generators (Ueber den Parallelbetrieb mit Wechelstrommaschinen). Dr G. Benischke. A study of the conditions under which satisfactory parallel driving is practicable, with wave diagrams and a description of a mechanical model by which the action can be illustrated. 5000 w. Elektrotech Zeitschr—Dec. 14, 1899. No. 31558 B.

Power Station.

See Street and Electric Tramways.

Rotary Converters.

Some Notes on Rotary Converters, with Special Reference to the Extension Plant of the Chicago Edison Company. A. C. Eborall. Begins to present claims of the motor-generator as compared with the rotary converter. 2200 w. Elec Rev, Lond—Nov. 24, 1899. Serial. 1st part. No. 31222 A.

St. Gabriel, Canada.

Jacques-Cartier Water-Power Plant. Describes an interesting Canadian plant which utilizes a fall of 30 feet. Ill. 900 w. W. Elect'n—Dec. 9, 1899. No. 31-318.

Ticino.

The Hydro-Electric Plant of the Ticino at Vizzola (L'Impianto Idroelettrico di Vizzola Ticino). An illustrated description of the dam, canal, and power house. A fall of 28 metres is obtained and it is expected that 19,000 h. p. will be developed. Two articles, 2500 w. L'Elettricità—Nov. 4, 11, 1899. No. 31-567 each B.

HEATING AND WELDING.

Electrical Heating.

The Position of the Electrical Heating Industry in This Country. Discusses the position in England, and the reasons why progress has not been more rapid. Also the advantages. 1600 w. Elec Rev, Lond—Dec. 15, 1899. Serial. 1st part. No. 31607 A.

LIGHTING.

Australia.

Activity in the Electrical Field in Australia. C. Paulo Rei. A review of the rapid development of electric light plants and the construction of tramways, etc. 2200 w. W Elect'n—Dec. 2, 1899. No. 31177.

Hereford, Eng.

Hereford Electricity Works. Illustrated description of the lighting plant recently installed. 3500 w. Elec Eng, Lond—Dec. 15, 1899. Serial. 1st part. No. 31606 A.

Lamps.

The Incandescent Electric Lamp. Discusses recent statements in regard to their use and manufacture. 2200 w. Jour Gas Lgt—Dec. 12, 1899. No. 31451 A.

Miner's Lamp.

See Mining & Metallurgy, Mining.

Music Hall.

Electrical Features of the Fine Arts Building. Illustrated description of interesting features in a fine Chicago building. 2000 w. W Elect'n—Dec. 23, 1899. No. 31498.

Photometry.

The Spectrophotometry of Electric Lights (Sur la Spectrophotométrie des Lumières Electriques). Fernand Gaud. A communication to the French Academy giving the results of photometric measurements of the intensity of various parts of the spectra of different lights. 600 w. Comptes Rendus—Nov. 13, 1899. No. 31539 D.

St. Louis, Mo.

The Design and Construction of a Modern Central Lighting Station. H. H. Humphrey. A discussion of the design and construction of the plant of the Imperial Electric Light. Heat and Power Co., of St. Louis. Ill. 8000 w. Jour Assn of Engng Socs—Oct., 1899. No. 31126 C.

Windsor.

The Electric Lighting at Windsor. Illustrates and describes the application of electricity to street lighting. 1700 w. Elec Engr, Lond—Dec. 8, 1899. No. 31393 A.

MEASUREMENT.

Alternations.

Device for Measuring the Number of Alternations (Instrument zur Ermittelung der Wechselzahl). E. Stöckhardt. The number of vibrations is determined by the tone emitted from a tuning fork fitted with adjustable weights and actuated by the alternations of the current. 1000 w. Elektrotech Zeitschr—Dec. 14, 1899. No. 31559 B.

Power Factor.

Power Factor Measurement. Aug. J. Bowie, Jr. Mathematical discussion, giving curves and tables. 3000 w. Elec Wld & Engr—Dec. 9, 1899. No. 31314.

Pressure.

The Fall in Pressure in Alternating Generators (Ueber den Spannungsabfall bei Wechelstromgeneratoren). B. A. Behrend. A comparison of the methods of Behn-Eschenburg and Rothert for measuring the fall in pressure, showing the latter to be untrustworthy. 3500 w. Elektrotech Zeitschr—Nov. 30, 1899. No. 31551 B.

Self Induction.

Measurements of Self-Induction of Various Kinds of Submarine Cables (Messungen über die Selbstinduktion Verschiedener Muster für Seekabel). Dr. F. Breisig. With sections of cables of various arrangements of cores and a description of the method of measurement of self-induction to be employed for each. 3500 w. Elektrotech Zeitschr—Nov. 30, 1899. No. 31553 B.

Switch.

Measuring Switch for High Tension Systems (Mess-Schaltung für Höchspannungs-Anlagen). L. Schüler. An illustrated description of a combined switching and measuring system, using a transformer to enable low pressure measuring instruments to be used. 1800 w. Elektrotech Zeitschr—Dec. 14, 1899. No. 31557 B.

POWER APPLICATIONS.

Agriculture.

Electric Energy in Agriculture (L'Energie Electrique en Agriculture). Paul Renaud. Chiefly devoted to the Zimmermann electric plow, with illustrations of construction, and details of performance. Serial, part I. 1500 w. Revue Technique—Dec. 10, 1899. No. 31513 D.

Alternating Motors.

Alternating-Current Power Motors. W. A. Layman. Discusses the difference between direct and alternating currents, and between direct and alternating-current motors, considering in detail the motor brought out by the Wagner Elec. Mfg. Co., of St. Louis. Ill. 5000 w. Jour Assn of Engng Soc's—Nov., 1899. No. 31488 C.

Arsenal.

The Application of Electric Energy at the Royal Arsenal at Spezia (L'Energia Elettrica pel Regio Arsenale Militare Marittimo della Spezia). A. Raddi. An argument in favor of the utilization of the river Magra as a source of power to be transmitted electrically to the arsenal at Spezia. 2500 w. Giord Lav Pub e d Str Ferr—Nov. 15, 1899. No. 31574 B.

Boats.

Electric Boats (Elektrische Boote). Max Büttner. With illustrations of various boats used in Germany, also giving construction of controllers and data as to the performance of the accumulators. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1899. No. 31521 D.

Electric Power.

See Mining and Metallurgy, Mining.

Enclosed Motor.

The Enclosed Electric Motor. Sydney F. Walker. Discusses the advantages and disadvantages, and things of importance in designing these motors. 2000 w. Elec Rev, Lond—Dec. 15, 1899. No. 31608 A.

Haulage.

Electric Haulage for Canals (Elektrische Kanalschleppschiffahrt). E. Müllendorff. Giving illustrations of various systems of electric traction for canals, with a comparison of their advantages. 2500 w. Glaser's Annalen—Nov. 15, 1899. No. 31534 D.

Induction.

Induction Motors. R. F. Markill. Describes the action of the induction motors and briefly reviews their history. 1100 w. Jour of Elec—Nov., 1899. No. 31429.

TRANSMISSION.

California.

The Mount Whitney Power Company. Illustrated description of a long-distance high-tension power transmission system in California. 2200 w. Elec Rev, N. Y. —Dec. 20, 1899. No. 31446.

Power Transmission.

Waterport-Albion Power Transmission. Orrin E. Dunlap. Illustrated description of a new plant in New York State. 1300 w. W. Elect'n—Dec. 2, 1899. No. 31176.

Three-Phase.

The Disposition of Three-Phase Transmission Lines. Aug. J Bowie, Jr. Discusses the arrangement of the wires and gives a mathematical solution showing the effect of unequal inductance in given examples. 2500 w. Jour of Elec—Nov., 1899. No. 31428.

MISCELLANY.

Address.

Prof. Sylvanus P. Thompson's Presidential Address to the Institution of Electrical Engineers. Discusses the progress of electrical engineering and the tendencies. 4000 w. Elect'n, Lond—Nov. 24, 1899. Serial. 1st part. No. 31227 A.

Japan.

Electricity in Japan. A review of the progress made, giving tabulated information of the Japanese electric companies and stations. Ill. 700 w. Elec Wld & Engr—Dec. 2, 1899. No. 31173.

GAS ENGINEERING

GAS ENGINEERING.

Acetylene.

Acetylene. A brief review of what has been learned regarding the manufacture and use, and of the work to which it has been satisfactorily applied. 1400 w. Builder—Nov. 25, 1899. No. 31232 A.

Acetylene Lighting. F. Cortez Wilson. Read before the Chicago Architects' Club. An outline of facts that have been determined in connection with acetylene lighting. 3300 w. San Plumb—Dec. 1, 1899. No .31308.

The Application of Acetylene Lighting to Railway Purposes (Die Anwendung der Acetylenbeleuchtung für Eisenbahnzwecke). Dr. Paul Wolff. A description of the installation of the Pietet-Wolff apparatus at the Schlachtensee Railway Station in Berlin. 3000 w. Ill. Zeitschr f Klein u Strassenbahnen—Oct. 16, 1899. No. 31576 D.

Ammonia.

Report on Sulphate of Ammonia Experiments. Report of Mr. John Hunter on the statistics of competitions for root growing in 1898. 1400 w. Gas Wld—Dec. 16, 1899. No. 31605 A.

Automatic Lighting.

The Besnard System of Automatically Lighting and Extinguishing Public Lamps. An illustrated description of an appliance for utilizing gas pressure. 1300 w. Jour Gas Lgt—Dec. 5, 1899. No. 31390 A.

Carbide.

Is Fine or Coarse Material to be Preferred in the Production of Calcium Carbide (Ist Fein Pulverisiertes oder Grob Gekörntes Rohmaterial bei der Herstellung von Calcuimcarbid Vorzuziehen?) Birger Carlson. Showing the advantages of using coarsely ground material over that reduced to a fine powder. 1800 w. Zeitschr f Elektrochemie—Dec. 7, 1899. No. 31563 G.

Coin Meters.

The Automatic Coin Meter. Norton H. Humphrys. Discusses their use, referring to recent papers and their discussions. 2700 w. Jour Gas Lgt—Dec. 12, 1899. No. 31452 A.

Electrical Gas.

An Alleged Electrical Gas Process. Exposing the worthlessness of the process being promoted by Dr. J. W. Chisholm. 3800 w. Eng News—Dec. 7, 1899. No. 31284.

Furnace Gases.

The Utilization of Blast-Furnace Gases in the Generation of Electricity. Considers its applicability, discussing its thermal and chemical qualities, and the methods tried. 2500 w. Elec Rev, Lond—Dec. 15, 1899. Serial. 1st part. No. 31609 A.

Utilization of High-Furnace Gases for Power in Gas Engines. Bryan Donkin. Discusses the application of these gases to produce power, and describes the two-cycle engine. Ill. 2000 w. Engr, Lond—Nov. 24, 1899. Serial. 1st part. No. 31211 A.

Gasholders.

Gasholder Design (Gasbehälterführungen). H. Hacker. Methods of computing the stresses on gasholders of various kinds are given, especial consideration being given to wind stresses. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1899. No. 31522 D.

Gas Works.

Modern Improvements in the Plant of Gas Works: Especially With Reference to the Saving of Manual Labor. J. T. Westcott. Briefly outlines methods used in earlier works, and shows the labor-saving appliances now in use in the retort house. 3000 w. Am Gas Lgt Jour—Dec. 25, 1899. No. 31497.

Leakage.

Causes and Correction of Water and Gas Main Leakage. Gives statements made by various authorities concerning existing conditions, and discusses the remedy. 3500 w. Sci Am Sup—Dec. 23, 1899. No. 31440.

Legislation.

Some Disputed Points in Gas and Water Works Legislation. Thomas Newbigging. Read before the Manchester Dist. Inst. of Gas Engs. Also discussion. Considers the proper amount of the reserve fund, and the borrowing powers. 6000 w. Jour Gas Lgt—Nov. 28, 1899. No. 31245 A.

Mains.

Laying Gas and Water Mains in Public and Private Streets. Arthur Graham. Read before the Manchester Dist. Inst. of Gas Engs. Also discussion. Advises a pushing policy. Laying mains and if necessary giving outlets free. 2800 w. Jour Gas Lgt—Nov. 28, 1899. No. 31246 A.

Mantles.

Incandescent Mantles. Vivian B. Lewes. Lecture delivered before the members of the Incorporated Inst. of Gas Engs., England. Part first reviews the history and development of mantles, and gives some of the explanations of the wonderful light given. 4500 w. Gas Engs.' Mag—Dec. 11, 1899. Serial. 1st part. No. 31636 A.

Profit-Sharing.

Profit-Sharing, or Payment by Results. G. W. Lupton. Read before the Manchester Dist. Inst. of Gas Engs. Also discussion. Discusses this scheme favorably. 3800 w. Jour Gas Lgt—Nov. 28, 1899. No. 31247 A.

Water Gas.

Dellwick Water-Gas Process. Dr. G. Lunge. Translated from the *Journal für Gasbeleuchtung und Wasserversorgung*. A description of the Dellwick process as at present carried on, with statements concerning its advantages and value. Ill. 5400 w. Pro Age—Dec. 1, 1899. No. 31133.

Iron Carbonyl in Water Gas. M. van Breukelween and A. ter Horst, in *Het. Gas*. Abstract. On the inconveniences caused by its presence, with investigation of causes. 1000 w. Jour Gas Lgt—Nov. 21, 1899. No. 31165 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Contract Trial of the United States Seagoing Battleship Kearsarge. Claude B. Price. Illustrated description of vessel and equipment, with report of trial. Plates. 6500 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31233 H.

Steam Trials of the Battleship Goliath. The engines are of the three-cylinder, inverted, triple-expansion type. The trials are described. 1000 w. Engr, Lond—Dec. 8, 1899. No. 31424 A.

Boats.

See Electrical Engineering, Power Applications.

Coast Defence.

The New French Armor-Clad "Henri Quatre." Brief illustrated description. 500 w. Sci Am—Dec. 9, 1899. No. 31260.

Cruisers.

Launch of H. M. S. Cressy. This is a sister ship of the Sutlej, previously described, so the description is principally devoted to special features, peculiar to this vessel. 2500 w. Engr, Lond—Dec. 8, 1899. No. 31423 A.

New Cruisers for the American Navy. Illustration, with description of vessels of the Chattanooga class. 1800 w. Engr, Lond—Nov. 24, 1899. No. 31215 A.

Ferrying.

Car Ferrying on the Great Lakes. Waldon Fawcett. Illustrates and describes some of the boats used in this service, giving an account of their efficiency. 1500 w. Loc Engng—Dec., 1899. No. 31146 C.

Gunnery.

Terms Used in Modern Gunnery. F.

Maurice. An explanation of such terms as "Creusot," "Krupp," "Shrapnel," "Common-Shell," "94-pounders," "4.7 inch guns," "Mausers," "Lee-Enfield," etc. 4800 w. Nineteenth Cent—Dec., 1899. No. 31385 D.

Launch Engine.

See Mechanical Engineering, Special Motors.

Liner.

The New Australian Liner "Ortona." Description, with report of trials. 1000 w. Engng—Nov. 24, 1899. No. 31209 A.

Lost Vessels.

Loss of the U. S. S. Charleston and Burning of the S. S. Patria at Sea. Illustrations of these vessels, and a brief account of the disasters. 900 w. Marine Engng—Dec., 1899. No. 31317 C.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Naval Architects.

Seventh General Meeting of the Society of Naval Architects and Marine Engineers. Report of the meeting, giving abstracts of papers and discussions. 31500 w. Marine Engng—Dec., 1899. No. 31315 C.

Oceanic.

The Steamship "Oceanic" (Le Paquebot "Oceanic"). M. Hachebet. A general description of the White Star liner, with numerous illustrations. 2500 w. Génie Civil—Nov. 25, 1899. No. 31500 D.

Piping.

Object-Lessons. A. B. Willits. On the installation of piping on steamships, and a peculiar condition of the propeller shaft of the Helena, which was ruptured. Ill. 1500 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31235 H.

Report.

The Annual Report of the Engineer-in-Chief. From the report of George W. Melville, giving the important parts. 18300 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31234 H.

Salvage.

Notable Salvage Operations of the Past Year. Waldon Fawcett. An interesting account of the work of the engineer in the peculiar field of saving and repairing wrecked and disabled vessels. With illustrations of recent important operations. 3000 w. Engineering Magazine—Jan., 1900. No. 31592 B.

Shipbuilding.

The Record of the Year in Steel Shipbuilding. Waldon Fawcett. Showing the development and advancement in the United States in 1899. 2500 w. Ir Age—Dec. 14, 1899. No. 31342.

Shipping Bill.

America's Shipping Bill. Arguments that accompany the bill and which are made a part of it, as introduced in the Fifty-Sixth Congress. 2200 w. Marine Rev—Dec. 14, 1899. No. 31388.

Steamers.

Shallow Draft Stern Wheel Steamers and Barges for Mexican Government. Illustrated description of interesting small vessels built at Algiers, La. 500 w. Marine Engng—Dec., 1899. No. 31316 C.

Submarine.

The "Goubet No. 2" at Toulon (Le "Goubet No. 2" à Toulon). Emile Duboc. A discussion of the merits of this submarine boat, as shown by its trip from St. Ouen to Toulon. A view of the boat in dry-dock is given. 1800 w. Le Yacht—Nov. 18, 1899. No. 31570 B.

The Problem of Submarine Navigation (Le Problème de la Navigation Sous-Marin). H. Noalhat. A discussion of the problems of immersion and orientation of submerged vessels, treated from a theoretical point of view. Serial, part I. 2000 w. Revue Technique—Dec. 10, 1899. No. 31515 D.

The Submarine Boat and Its Future. Waldon Fawcett. An outline of the recent tests of the Holland, and review of boats tried in France, with some of the views concerning the utility of such boats in warfare. Ill. 1700 w. Sci Am—Dec. 9, 1899. No. 31259.

Warships.

Recent British Warships. Considers three typical modern types of the British fleet, a battleship, a cruiser, and a torpedo boat destroyer. Colored supplement. 3000 w. Engr, Lond—Dec. 15, 1899. No. 31618 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

High-Pressure Gas Accumulators for Automobiles. An article intended to suggest a new line of thought and experiment in connection with accumulators. 1200 w. Automotor Jour—Dec., 1899. No. 31639 A.

Bicycles.

Motobicycles. From *La Nature*. Illustrates and describes several new styles shown at the last automobile exhibition. 1200 w. Sci Am Sup—Dec. 9, 1899. No. 31261.

Boiler Feeding.

Boiler Feeding Apparatus. R. I. Clegg. Illustrates and describes various devices. 4000 w. Horseless Age—Dec. 6, 1899. No. 31274.

Burners.

Oil Fuel Burners. R. I. Clegg. Illustrates and describes three representative types. 2500 w. Horseless Age—Dec. 6, 1899. No. 31275.

Circulation.

Advantages of Circulation. S. D. Mott. Showing how the efficiency is increased by circulation. 2000 w. Horseless Age—Dec. 6, 1899. No. 31272.

Construction.

Recent Progress in Automobile Construction. W. Worby Beaumont. A review of the progress in details of motor vehicle construction during the past two years, showing the lines of advance in the removal of the mechanical imperfections revealed by experience. 3000 w. Engineering Magazine—Jan., 1900. No. 31587 B.

Exposition.

The Electric Carriages at the International Motor-Vehicle Exposition (Elektrische Fahrzeuge auf der Internationalen Motorwagen Ausstellung). Franz Wilking. With numerous illustrations of early and recent vehicles, and an extensive table giving details and dimensions of the various exhibits. 6000 w. Elektrotech Zeitschr—Nov. 23, 1899. No. 31550 B.

Fire Engine.

The Horseless Fire Engine. Captain Cordier. Illustrates and describes various machines in use or being constructed, with experimental information. 2800 w. Auto Mag—Dec., 1899. No. 31130 C.

Fuel.

A New Automobile Fuel, Electrolytic Alcohol. George H. Benjamin's account of automobilism in Russia, and of the low-priced, odorless fuel used. Ill. 1200 w. Elec Rev, N. Y.—Dec. 13, 1899. No. 31370.

Hose Wagon.

An Electric Hose Wagon. From *Le Magasin Pittoresque*. Illustrated description of a vehicle belonging to the Paris fire department. 1000 w. Sci Am—Dec. 23, 1899. No. 31439.

Military Vehicle.

A Military Motor Carriage. Illustrates and describes a three-wheeled motor carriage for military use, designed by R. P. Davidson. 450 w. Eng News—Dec. 7, 1899. No. 31283.

Motor Car.

The Alldays and Onion's Motor Car. Illustrated brief description of a four-seated petroleum-spirit motor car. 450 w. Ind & Ir—Dec. 1, 1899. No. 31328 A.

Motor.

La Voiture Darracq. Adapted from an article by L. Baudry de Saunier in *La Locomotion Automobile*. Illustrated description of a vehicle designed for general use. 1000 w. Automotor Jour—Dec., 1899. No. 31638 A.

New Motor Vehicles. Brief illustrated descriptions of the Humber motor vehicles, the "Star" motor car, and the "Swiss Mountaineer" car. 1000 w. Ind & Ir—Dec. 8, 1899. No. 31414 A.

The George Richard Carriage (La Voiture Georges Richard). Gaston Sencier. An account of the Richard petroleum automobile, describing the manipulation, and giving a list of the important events in which it has participated. 2500 w. Revue Technique—Nov. 25, 1899. No. 31512 D.

The Georges Richard Motor Carriage. Illustrates and describes this vehicle, its management, and care needed, giving also results of some races. 2000 w. Automotor Jour—Dec., 1899. No. 31640 A.

The Locomobile. R. I. Clegg. Illustrated description of the operating mechanism. 1800 w. Horseless Age—Dec. 6, 1899. No. 31276.

Petroleum.

The Bennett and Thomas Petrol Motor. Illustrated description of a motor claiming the advantages of absence of vibration, noiseless, smooth running and simplicity. 1200 w. Automotor Jour—Dec., 1899. No. 31637 A.

Racing Car.

The Vallée Racing Car. Illustrates and describes a car constructed for racing, noting its special features. 600 w. Ind & Ir—Dec. 1, 1899. No. 31329 A.

Record.

A Record Making Automobile. J. B. Entz and H. P. Maxim. Illustrations and details of the electric automobile which lately brought the world's record for these vehicles to this country. 2000 w. Elec Wld & Engr—Dec. 23, 1899. No. 31601.

Stanley Show.

Cycles and Motor Cars at the Stanley Show. Editorial review of the exhibits, noting the novel features. 4200 w. Engng—Nov. 24, 1899. No. 31208 A.

Station.

The Newport (R. I.) Electrical Automobile Station. Spencer C. Crane. An illustrated description of the station and vehicles of the New England Electric Vehicle Transportation Co., with an account of the success of the enterprise. 2500 w. Elec Wld & Engr—Dec. 16, 1899. No. 31407.

Steam Car.

The Stanley Steam Car. Illustrated description. 1200 w. Ind & Ir—Dec. 15, 1899. No. 31613 A.

Traction Engines.

Traction Engines in South Africa. Illustrates and describes these engines, showing the development to fit them for Colonial work. Report of the commission sent out to obtain information of their work. 3800 w. Engr, Lond—Dec. 8, 1899. No. 31425 A.

Traction Engines in War. Illustrated description of these engines, about to be given a trial in the Transvaal campaign. 600 w. Engr, Lond—Nov. 24, 1899. No. 31216 A.

Vehicle Boilers.

Considerations in the Design of Vehicle Boilers. P. M. Heldt. Discusses the time required in the operation, the fuel, types of boilers, etc. 2200 w. Horseless Age—Dec. 6, 1899. No. 31273.

Steam Boilers for Motor Vehicles. R. I. Clegg. An illustrated historical review. 7400 w. Horseless Age—Dec. 6, 1899. No. 31271.

Wheels.

The World on Wheels. Edwin Emerson, Jr. Historical review of the progress of wheeled vehicles. Ill. 2400 w. Auto Mag—Dec., 1899. No. 31131 C.

HYDRAULICS.

Pumping Engines.

Comparison Between High and Low Duty Pumping Engines on a Small Water Works Plant. John E. Smith. Facts from the reports of the Andover Water Commissions for 1895, '96 and '97. Describes the conditions and system with improvements. 3400 w. Jour N. E. W Wks Assn—Dec., 1899. No. 31383 E.

Pumping.

The Kaselowsky Pumping System. Charles Francois. Abstract of paper in the *Revue Universelle des Mines.* Illustrates and describes a subterranean pump operated by hydraulic pressure. 700 w. Eng & Min Jour—Dec. 23, 1899. No. 31496.

Turbine.

The Construction and Operation of the Transformer Turbine (Bericht über die Konstruktion und Wirkungsweise der Transformator Turbine). F. Prásil. A description of the improved turbine by which sufficiently high speeds may be obtained for direct driving of electric generators from low-pressure water. Three articles, 7500 w. Schweizerische Bauzeitung—Nov. 25, Dec. 2, 9, 1899. No. 31538 each B.

Water Wheels.

Some Old-Time Water Wheels. William Wallace Christie. Historical review of wheels used for water power, giving information of interest. 1500 w. Eng News—Dec. 21, 1899. No. 31460.

MACHINE WORKS AND FOUNDRIES.

Brass Furnace.

A German Brass Furnace. An illustrated description of a furnace near Chemnitz, which differs in construction and operation from American practice. 2000 w. Foundry—Dec., 1899. No. 31443.

Casting.

Casting a Header in the Floor. R. H. Palmer. Illustrated description of the work. 2200 w. Am Mach—Dec. 28, 1899. No. 31633.

The Casting of Plates. R. H. Palmer. Suggestions concerning methods of molding. Ill 1000 w. Foundry—Dec., 1899. No. 31444.

Cranes.

Modern Electric Cranes (Neuere Elektrisch Betriebene Hebezeuge). With illustrations of the construction and method of erection of the 150 ton electric crane recently built by the Benrath Machine Works for the port of Bremerhaven. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—December 2, 1899. No. 31523 D.

Radial Crane of 100 Tons Capacity (Grue Pivotante de 100 Tonnes). Illustrated description of large steam wharf-crane of variable radius, recently installed at the shipbuilding establishment of Blohm & Voss, at Hamburg. 1500 w. Génie Civil—Dec. 2, 1899. No. 31503 D.

Dies.

Making a Compound Die for Punching an Irregular Piece in a Sub-press. Lundvald and Klute. Illustrated description of best method of construction. 1500 w. Am Mach—Dec. 28, 1899. No. 31632.

Lathes.

44-inch Turret Chucking and Turning Lathe. Illustrated description of a machine designed by John J. Grant. 600 w. Am Mach—Nov. 30, 1899. No. 31142.

Machine Tools.

Machine Tools at the Stanley Show. Illustrated account of such machines as were shown for the first time. 5700 w. Engng—Nov. 24, 1899. No. 31206 A.

Planing.

A Much Extended Planer Tool. Oberlin Smith. Illustrated description of a special tool with a "nose" about 8 feet long. 1000 w. Am Mach—Dec. 21, 1899. No. 31431.

Premium System.

Actual Experience with the Premium System. H. M. Norris. An interesting account of an attempt to introduce the premium system into an American works, and the obstructive attitude assumed by union labor. 5000 w. Engineering Magazine—Jan., 1900. No. 31591 B.

The Reference or Premium Plan. Isaac Ross. An explanation of a system that has been worked successfully for seven years. 1500 w. Am Mach—Dec. 7, 1899. No. 31266.

Projectiles.

The Making of Large Projectiles. Jas. A. Murphy. Illustrated description. 1300 w. Foundry—Dec., 1899. No. 31-445.

Pulp Machines.

Machines for the Manufacture of Wood Pulp (Machines à Fabriquer la Pate de Bois et le Carton). With illustrations of wood-grinding and pasteboard machines. 1200 w. 1 plate. Génie Civil —Dec. 2, 1899. No. 31504 D.

Shop-Practice.

The Revolution in Machine Shop Practice. Henry Roland. Mr. Roland's fourth paper discusses the practical limitations of tool making as illustrated by the very highly-organized automatic machines used in an American watch factory. 3500 w. Engineering Magazine—Jan., 1900. No. 31588 B.

Shops.

Shops of Baker Brothers, Toledo, Ohio. Illustrated detailed description of new works made necessary by growing business. 1200 w. Am Mach—Dec. 14, 1899. No. 31369.

Staybolts.

Staybolt Progress. Considers material used, form of the fire box, and of stay bolts, riveting, etc., with conclusions. Ill. 5200 w. Am Engr & R R Jour—Dec., 1899. No. 31178 C.

Sweden.

The New Atlas Works, Stockholm. Illustrated detailed description. 2000 w. Am Mach—Nov. 30, 1899. No. 31143.

MATERIALS OF CONSTRUCTION.

Bursting Strength.

The Expansion of Thick Cylinders Under Bursting Pressure—Pressing on Thick and Thin Disks. J. H. Dunbar. Illustrated description of experiments made to note the change in shape likely to take place in the hubs of cast-iron wheels when pressed on by hydraulic presses. 1000 w. Am Mach—Dec. 7, 1899. No. 31269.

Copper.

Copper in Steel. Albert Ladd Colby. A summary of the report presented at Philadelphia meeting, Nov. 17, of the Am. Soc. of the International Assn. for Testing Materials and the Assn. of Am. Steel Mfrs. Discusses experiments. 6000 w. Ir Age—Nov. 30, 1899. No. 31120.

Elasticity.

The Elasticity of Steel Balls and Plates. Alton L. Smith. Concerning ball-bearings and tests recently made. Ill. 2000 w. Jour of Worcester Poly Inst—Nov., 1899. No. 31128 C.

Sheet Iron.

Computations for Rectangular Sheet Iron Plates (Calcul des Tôles Rectangulaires). M. Koechlin. A mathematical discussion of the strength of a rectangular plate of sheet iron supported at two or four edges, and uniformly loaded over the entire surface. 2500 w. Génie Civil —Nov. 25, 1899. No. 31502 D.

POWER AND TRANSMISSION.

Belt Dressings.

Effect on Transmitting Power of Belts of Dressing with Special Materials. R. C. Carpenter. A report of Sibley College tests, showing that the carrying capacity of a belt may be very much increased by dressings. 1600 w. Ill. Sib Jour of Engng—Dec., 1899. No. 31-406 C.

Compressed Air.

Compressed Air in the Shop. Illustrated description of air compressors and compressed air appliances. 5500 w. Mach, N. Y.—Dec., 1899. No. 31151.

Report on Trials Made at Magog, Quebec, to Test the Economy Effected by Compressed Air. J. T. Nicolsen. Trials were made at the Dominion Cotton Mill, where there is installed a 150-h. p. hydraulic air-compressing plant. 1600 w. Can Elec News—Dec., 1899. No. 31389.

Some Compressed Air Queries. Frank Richards. An explanation of some points in the writer's book on "Compressed Air," called out by a letter from Ireland. 1400 w. Am Mach—Dec. 7, 1899. No. 31267.

Gearing.

Electric Driving by Toothed Gearing (Elektrischer Antrieb mittels Zahnradübertragung). O. Lasche. Especially devoted to the influence of the form of tooth upon the wear. The conditions of durability in electric tramway service are considered. Three articles, 10000 w. Zeitschr d Ver Deutscher Ing—Nov. 18, Dec. 2, 9, 1899. No. 31518 each D.

The Grisson Driving Gear (Grisson-Getriebe). R. Grisson. An illustrated description of a gear for use with tramway motors. Two heart-shaped cams engage with rollers mounted on a driven disk. 3500 w. Die Elektrizität—Nov. 25, 1899. No. 31565 B.

Tumbler Gearing. P. J. Connor. Illustrates a useful device for reversing the motion of driven shafts. 500 w. Mach, N. Y.—Dec., 1899. No. 31153.

Pneumatic Tube.

Pneumatic Mail Transmission for Chicago. Reviews the introduction of this system in the United States, and the plans for Chicago. 1200 w. Mod Mach—Dec., 1899. No. 31171.

Shafting.

Flywheel Effects on Shafting. W. H. Booth. Discusses this subject and the difference between American and English practice. 1200 w. Am Mach—Nov. 30, 1899. No. 31141.

Transport Appliances.

Mechanical Transport in Mining and Engineering Works. A. J. S. B. Little. Mr. Little's second paper is devoted to many forms of labor-saving appliances in connection with ore-handling and metallurgical processes. 3500 w. Engineering Magazine—Jan., 1900. No. 31586 B.

SPECIAL MOTORS.

Furnace Gases.

See Gas Engineering.

Gas Engine Plant.

A Large Double-Acting Two-Cylinder Gas Engine. Illustrated description of a plant used for operating the dynamos of an electric railway. 1200 w. Eng Rec—Dec. 2, 1899. No. 31198.

Gas Engines.

Future of the Gas Engine. M. A. Hicksman. On the expansion that may be looked for in connection with recent developments, especially in the large units. 1000 w. Mod Mach—Dec., 1899. No. 31170.

Gas Engine Guarantees. William T. Magruder. Abstract of paper read at meeting of the Nat. Assn. of Gas and Gasoline Eng. Mfrs. Considers such guarantees as power ratings, regulation, cost of running and fuel consumption. 3500 w. Mod Mach—Dec., 1899. No. 31172.

Motor.

The Kinetic Motor. Describes this motor, now in use between Babylon and Farmingdale, on the Long Is. Ry. and illustrates one of the trucks. 900 w. R R Gaz—Dec. 1, 1899. No. 31163.

Petroleum.

Petroleum Motors for Coal Mine Haulage. M. J. Kersten. Abstract of a paper in *Annales de Mines de Belgique.* Describes a type of locomotive working with benzine, which is claimed to be safe and economical. 900 w. Eng & Min Jour—Dec. 16, 1899. No. 31395.

STEAM ENGINEERING.

Boiler Compounds.

The Use of Boiler Compounds. Albert A. Cary. Divides these compounds into three divisions, discussing each in detail. 3500 w. Am Mach—Dec. 7, 1899. No. 31268.

Compound Engine.

Single-Cylinder Compound Steam Engine (Eincylinder-Verbunddampfmaschine). C. Sondermann. A trunk piston is used, with an annular space in the middle portion, serving as a high-pressure cylinder. 1500 w. Zeitschr d Ver Deutscher Ing—Dec. 9, 1899. No. 31525 D

Condenser.

Central Condensing Plants for Ironworks. W. H. Roy. Read before the West of Scotland Iron and Steel Inst. A discussion of points to be kept in mind, types, etc., illustrating and describing various plants. 3500 w. Col Guard—Nov. 24, 1899. Serial. 1st part. No. 31219 A.

Engine Efficiency.

Logarithmic-Graphical Method of Determining the Power and Efficiency of Steam Engines (Logarithmisch-Zeichnerisches Verfahren zur Bestimmung des Arbeit und des Gütegrades der Dampfmaschinen). A. S. Oesterreicher. With graphical diagrams for enabling the capacity and efficiency of steam engines to be determined with a minimum of calculation. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 18, 1899. No. 31519 D.

Exposition.

The Power Plant of the Exposition of 1900 (Le Service des Installations Mécaniques á l'Exposition de 1900). G. Leugny. A general view of the great power-house of the exposition, with especial details of the flues leading to the great chimneys and the subways for steam and water pipes. 2000 w. Revue Technique—Dec. 10, 1899. No. 31514 D.

The Power Plant of the Paris Exposition. An illustrated description. 1400 w. Power—Dec., 1899. No. 31435 C.

Fuel Economy.

Fuel Economy Resulting from a Study of Indicator Cards. W. E. Symons. From a discussion of the report: To What Extent Do Draft Appliances, Valves and Valve-Setting and Cylinder Packing Influence Economy of Fuel, presented at the Atlanta meeting of the Southern and Southwestern Railway Club. 900 w. R R Gaz—Dec. 29, 1899. No. 31630.

Furnaces.

Furnace Efficiency. A. Bement. Considers other losses than those arising from incomplete combustion and other conditions which may decide superiority. 2200 w. Power—Dec., 1899. No. 31438 C.

Governors.

The Fly-Ball Governor. H. H. Kelley. An illustrated description of this class of governors and their operation. 1500 w. Engr, U. S. A.—Dec. 15, 1899. Serial. 1st part. No. 31430.

Indicator.

A Continuous Mean-Pressure Indicator for Steam-Engines. William Ripper. Gives description of the instrument; short-stroke type; long-stroke type, time-pressure diagrams. Relation between time-pressure and distance-pressure diagrams, etc. Ill. 4500 w. Inst of Mech Engs—Dec. 8, 1899. No. 31391 D.

Launch Engine.

The Griffin Oil Launch Engine. Illustrated detailed description. 1600 w. Engng—Nov. 24, 1899. No. 31210 A.

Marine Engines.

Engines of H. M. First-Class Battleship Ocean. Illustrations and description of engines of the triple-expansion type, steam being supplied by Belleville boilers. 900 w. Engr, Lond—Dec. 1, 1899. No. 31345 A.

The Engines of British Cruisers (Machines de Croiseurs Anglais). With illustrations and descriptions of the engines of the Proserpine and the Psyche. 1200 w. Revue Technique—Nov. 10, 1899. No. 31507 D.

Triple-Expansion Engines of the Dutch Cruiser Noord Brabant. Illustrated details of the engines and machinery. 1600 w. Engr, Lond—Dec. 8, 1899. No. 31422 A.

Moisture.

Moisture in Steam (De l'Humidité de la Vapeur). N. François. A discussion of the various methods of determining the proportion of water entrained in steam. 6000 w. Rev Univ des Mines—Nov., 1899. No. 31582 G.

Power-House Engines.

The Steam Engine for the Electric-Traction Power-House. C. A. Hague. Mr. Hague's second paper discusses detailed problems in design as well as in the erection of large steam units, giving valuable illustrations from the best current practice. 3000 w. Engineering Magazine—Jan., 1900. No. 31590 B.

Steam.

The Cost of Steam Raising. John Holliday. Read before the Inst. of Elec. Engs., England. Discusses the cost of producing steam without reference to the production of power, considering the different items. 5800 w. Elec Eng, Lond—Nov. 24, 1899. No. 31228 A.

Superheating.

Superheating Steam. J. H. Ashby. Abstract of paper read before the Cleveland Inst. of Engs. Aiming to show the advantages of superheating, especially in the Cleveland district. Discussion. 3500 w. Col Guard—Dec. 15, 1899. No. 31622 A.

Test.

Test of a Direct-Connected Railway Unit at Different Loads. Gives the results of tests of a 300-K. W. plant comprising water-tube boiler, horizontal compound condensing engine with double eccentrics, and a 6-pole generator. 900 w. Eng Rec—Dec. 23, 1899. No. 31485.

Thermal Efficiency.

The Thermal Efficiency of Steam Engines. Main portion of the report of the committee appointed by the Institution of Civil Engineers to consider a standard or standards of thermal efficiency for steam engines. 8500 w. Jour Am Soc of Nav Engs—Nov., 1899. No. 31237 H.

Valve Gear.

Investigations Upon Regulation With the Rider Valve Gear (Versuche über die Regulirung der Rider-Steverung). Dr. Camerer. An examination of the Rider valve-gear, with especial reference to the influence of friction upon regulation. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—Nov. 25, Dec. 2, 1899. No. 31520 each D.

MISCELLANY.

Air Resistance.

The Resistance of the Air. G. H Bryan. An account of the investigations of MM. l'Abbé Le Dantec and Canovetti. 1700 w. Nature—Nov. 30, 1899. No. 31319 A.

Artillery.

Siege Artillery. G. N. Whistler. Discusses the question of siege artillery and the conditions which have been produced by the introduction of the modern high-powered gun. 6500 w. Jour U. S. Artillery—No. 40, 1899. No. 31489 F.

The Determination of the Jump in Guns. John P. Wisser. Illustrates and describes a method of charting and measuring vibration by the use of electrical methods. 1200 w. Elec Rev, N. Y.—Dec. 27, 1899. No. 31635.

China.

Openings for Mechanical Engineers in China. Lord Charles Beresford. Read at meeting of British Inst. of Mech. Engs. Considers openings under the heads of: 1. Railways and electrical engineering. 2. Mining and allied works. 3. Manufacturers. Also discussion. 7800 w. Engng—Dec. 1, 1899. No. 31330 A.

Coast Fortifications.

The Gruson Chilled Cast-Iron Turrets to Be Manufactured in the United States. An illustrated description of the Gruson Turret, with an account of tests, and the preparations for their manufacture in this country. 3300 w. Ir Age—Dec. 28, 1899. No. 31626.

Discharge.

The Discharge of Gases and Vapours (Sur l'Ecoulement des Gaz et des Vapeurs). A translation of the paper Prof. Weyrauch recently published in the *Zeitschrift des Vereines deutscher Ingenieure.* 6000 w. Revue Technique—Nov. 10, 1899. No. 31510 D.

Education.

The Centennial Celebration of the Royal Technical High School at Berlin (Die Hundertjahrfeier der Königlichen Technischen Hochschule zu Berlin). M. Geitel. A brief history of the institution, together with an account of the recent celebration and a view of the buildings. 3500 w. Glaser's Annalen—Nov. 1, 1899. No. 31533 D.

The Question of Degrees in the Prussian Technical High Schools (Die Titelfrage an den Preussischen Technischen Hochschulen). Dr. P. v. Salvisberg. A discussion of the recent decree of the Emperor giving the right to confer the higher degrees to the technical high schools. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 2, 1899. No. 31546 B.

Elevator.

The Elevator at Saint-Germain-en-Laye (L'Ascenseur de Saint-Germain-en-Laye). Illustrated description of hydraulic elevator of 33 metres lift, by which the height of Saint-Germain-en-Laye, near Paris, is reached. 3000 w. Revue Technique—Nov. 25, 1899. No. 31511 D.

Export Exposition.

The National Export Exposition at Philadelphia. Illustrations of some of the interesting exhibits and an account of the exhibition. 6000 w. Power—Dec., 1899. No. 31437 C.

Liquid Air.

Latent Heat of Evaporation of Liquid Air. Walter H. Dickerson. Describes investigations, giving results. 1000 w. Compressed Air—Dec., 1899. No. 31167.

Pyrometers.

Pyrometers. Wallace Christie. A brief description of various methods that have been used for measuring high temperatures. Ill. 2000 w. Mach, N. Y.—Dec., 1899. No. 31152.

Refrigeration.

Hotel and Restaurant Refrigeration. E. T. Skinkle. Notes the special requirements and gives plan and elevation for modern cold storage room, and sectional views of "short order" box. 2200 w. Ice & Refrig—Dec., 1899. No. 31-203 C.

The Refrigeration of Dwellings. E. Brueckner. Shows the importance of pure cold air, and discusses the development of mechanical refrigeration and the scientific principles. 2300 w. Ice & Refrig—Dec., 1899. Serial. 1st part. No. 31204 C.

Sighting.

Automatic Sighting. H. S. S. Watkin. Reprinted from Pro. Royal Art. Inst. Discusses the theory and practice. Ill. 2400 w. Jour U. S. Artillery—No. 40, 1899. No. 31490 F.

Sugar Plants.

Sugar Machinery. Illustrated description of an installation of sugar machinery, with the crystallization in motion plant. 3500 w. Engng—Dec. 8, 1899. No. 31415 A.

MINING AND METALLURGY

COAL AND COKE.

British Coal.

The Coal Trade Centers of the United Kingdom. Part first illustrates and describes Cardiff. 3800 w. Ir & Coal Trds Rev—Nov. 24, 1899. Serial. 1st part. No. 31220 A.

Coals.

The Combustibility of Coals. O. Lang, in *Glückauf.* Investigations of the causes of spontaneous combustion. 1200 w. Am Mfr & Ir Wld—Dec. 7, 1899. No. 31277.

Coal Stamping.

An Electrically-Driven Coal-Stamping Machine. From *Glückauf*. Illustrated description of a machine used in preparing inferior coal for coking. 1300 w. Ir & Coal Trds Rev—Dec. 1, 1899. No. 31332 A.

Coal Stamping Machinery (Ueber Kohlenstampfmaschinen). A description of machinery used for consolidating soft coal preparatory to coking; with especial reference to the electrically driven machines now used in Silesia and in the Saar district. 1500 w. 1 plate. Glückauf—Nov. 25, 1899. No. 31541 B.

Coal Working.

New Method of Working at the Grand 'Combe Colliery. M. Destiral. From a communication to the Société de l'Industrie Minérale, St. Etienne. Illustrates and describes the method, discussing the cases in which it is applicable and its advantages. 3300 w. Col Guard—Dec. 8, 1899. No. 31418 A.

Coke-Making.

The Improved Otto System of Coke-Making. From *Stahl und Eisen*. Concerning the improved type of the Otto ovens, in which the regenerative principle has been abandoned, and the cause of the alteration. 1200 w. Col Guard—Dec. 8, 1899. No. 31419 A.

The Otto Coke Oven in Germany. Translated from *Glückauf*. Illustrates the new type of Otto oven, heated from below, stating the advantages, and giving analyses. 3300 w. Ir & Coal Trds Rev—Dec. 8, 1899. No. 31427 A.

Some Systems of Coking and Coke Ovens. Brief accounts of the various systems, with illustrations. 3500 w. Ir & Coal Trds Rev—Dec. 1, 1899. No. 31334 A.

Underfired Coke Ovens (Koksöfen mit Unterfeuerung). K. Hilgenstock. Especially describing the improved Otto by-product coke oven, with sectional details showing the construction. 3500 w. 1 plate. Glückauf—Dec. 2, 1899. No. 31542 B.

Indiana.

Coal Mining in Indiana. George H. Ashley. Abstract from the annual report of the Dept. of Geol. and Nat. Resources of the State of Indiana. Describes the geological features and methods of working. 4500 w. Mines & Min—Dec., 1899. No. 31251 C.

Queensland.

The Coal Beds of Queensland. T. Pearson Moody. From a paper read before the South Wales Inst. of Engs. Describes the deposits. 1600 w. Col Guard—Dec. 15, 1899. No. 31621 A.

Spontaneous Ignition.

Spontaneous Ignition of Coal. Extract from a report to the Sec. of the U. S. Navy, showing the conditions under which it occurs in bituminous coal, and how it may be guarded against. 3500 w. Mines & Min—Dec., 1899. No. 31250 C.

Victoria.

The Coalfields. On the fields of Victoria and their reliability. 1700 w. Aust Min Stand (special)—June 1, 1899. No. 31353 D.

COPPER.

Assaying.

Present Commercial Methods of Copper Assaying and Analysis. Titus Ulke. An outline of the daily work of a copper works chemist and assayer at a large refinery. 2700 w. Eng & Min Jour—Dec. 16, 1899. No. 31397.

Reduction-Roasting.

Reduction-Roasting—Its Value for Arsenic-Expulsion from Copper Ores and Mattes. Emilius W. Scherr, Jr. Describes investigations to ascertain to what extent arsenic is expelled from a previously well-roasted copper matte by a subsequent reducing roast with charcoal, the arsenic at the start being in combination with iron as arsenopyrite. 2500 w. Sch of Mines Quar—Nov., 1899. No. 31649 D.

Refining.

The Electrolytic and Mechanical Refining of Copper. J. Ohly. Reviews the history of the application of electrolysis, and its extensive use in the industries. 1200 w. Min Rept—Dec. 14, 1899. Serial. 1st part. No. 31420.

GOLD AND SILVER.

Ararat

The Ararat District. An illustrated account of its discovery and conformation, mines, etc. 1000 w. Aust Min Stand (special)—June 1, 1899. No. 31357 D.

Ballarat.

Famous Mines of Ballarat. Illustrated descriptions are briefly given. 3500 w. Aust Min Stand (special)—June 1, 1899. No. 31347 D.

Beechworth.

The Beechworth District. An illustrated description of this district, its mines and their development, methods, etc. 24500 w. Aust Min Stand (special)—June 1, 1899. No. 31354 D.

Bendigo.

The Bendigo District. An illustrated account of the city and surroundings, mines, deposits, development, etc. 50000 w. Aust Min Stand (special)—June 1, 1899. No. 31350 D.

British Columbia.

The Big Bend of the Columbia River. W. M. Brewer. Facts relating to the mines of this district. 1200 w. Eng & Min Jour—Dec. 2, 1899. No. 31187.

The Boundary District, British Columbia. Charles A. Bramble. Describes preparations made to work the mines of this district. 1400 w. Eng & Min Jour —Dec. 9, 1899. No. 31279.

The Granby Smelter, Boundary District, British Columbia. Charles A. Bramble. An illustrated description of the plant in process of erection. 2200 w. Eng & Min Jour—Dec. 16, 1899. No. 31398.

California.

Calaveras County Mines. Arthur Lakes. Illustrates and describes Angels Camp and the mother lode in Tuolumne County. 2400 w. Mines & Min—Dec., 1899. No. 31249 C.

The Upper Coffee Creek Mining District. Oscar H. Hershey. Arguments aiming to prove the permanent character of these mines. 1000 w. Min & Sci Pr—Dec. 16, 1899. No. 31442.

Castlemaine.

The Castlemaine District. Gives an illustrated description, noting its rise and progress, geology, mines etc. 14200 w. Aust Min Stand (special)—June 1, 1899. No. 31356 D.

Creswick.

Creswick. H. A. Westmoreland. Illustrated description of this valuable quartz goldfield. 2500 w. Aust Min Stand (special)—June 1, 1899. No. 31348 D.

Cripple Creek.

The Cripple Creek Gold Field. T. A. Rickard. Condensed from a paper read before the Inst. of Min. and Met. Part first describes the physical features of the district, and its geology. Ill. 2500 w. Min & Sci Pr—Dec. 16, 1899. Serial. 1st part. No. 31441.

Deep Leads.

The Deep Leads of Victoria. E. Lidgey. Describes the deposits and the wealth they have been proved to contain. 4200 w. Aust Min Stand (special)—June 1, 1989. No. 31361 D.

The London Valley Deep Leads. Reginald A. F. Murray. From the report of the government geologist. Descriptive. 2500 w. Aust Min Stand (special)—June 1, 1899. No. 31349 D.

Dredging.

Australian Dredging Progress. Explains the various operations usually confused with dredging proper, and gives an account of the work erroneously called hydraulic dredging in Victoria and New South Wales. 5500 w. Aust Min Stand (special)—June 1, 1899. No. 31364 D.

Dredging for Gold. Gives a detailed account of the evolution of the modern dredge as used for gold recovery. Ill. 5200 w. Aust Min Stand (special)—June 1. 1899. No. 31363 D.

Gold Dredging in New Zealand. W. M. Mackinnon. Illustrated description of the methods used in the district of Otago. 1500 w. B. C. Min Rec—Dec., 1899. No. 31371 C.

Drift Mining.

California Drift Mining. An illustrated detailed account of this industry. 2000 w. Min & Sci Pr—Nov. 25, 1899. No. 31138.

Fine Gold.

Loss of Fine Gold in Gippsland. Donald Clark. Concerning the serious loss that occurs in the treatment of the gold. 3200 w. Aust Min Stand (special)—June 1, 1899. No. 31352 D.

Gippsland.

The Gippsland District. An illustrated account of this district, its geological features, mines, etc. 16000 w. Aust Min Stand (special)—June 1, 1899. No. 31351 D.

Gold Deposits.

A List of Some of the Rocks and Minerals in Which Gold Has Been Found. E. Lidgey. 900 w. N. Z. Mines Rec—Oct. 16, 1899. No. 31450 B.

Gold Mills.

The Silver Plating of Amalgam Plates for Gold Mills. Allan Jay Clark. Illustrates and describes the plant installed for retreatment of these plates, at Lead, South Dakota. 3000 w. Sch of Mines Quar—Nov., 1899. No. 31648 D.

Maryborough.

The Maryborough District. An illustrated description of the gold fields, their value, important reefs, etc. 15300 w. Aust Min Stand (special)—June 1, 1899. No. 31355 D.

Mercur Mines.

De La Mar's Mercur Mines, Utah. H. L. J. Warren. Part first gives a brief account of the mines, the rock formation and character of the ores, describing the operations of mining and method of extraction. Ill. 2000 w. Eng & Min Jour —Dec. 23, 1899. No. 31494.

Mexico.

The Tajos Mine, Mexico. Frank B. Fowler. Describes these mines as an evidence of American energy and talent.

900 w. Eng & Min Jour—Dec. 2, 1899. No. 31188.

Nuggets.

The Origin of Nuggets. A. Liversidge. An illustrated account of investigations, with statement of conclusions. 3000 w. Aust Min Stand (special)—June 1, 1899. No. 31359 D.

Victorian Nuggets. Describes some of the interesting nuggets found, the number being greater than in any other part of the world. 3700 w. Aust Min Stand (special)—June 1, 1899. No. 31360 D.

Placers.

The Bear Gulch Placers, Montana. Fred D. Smith. Brief account of recent working of this field. Ill. 600 w. Eng & Min Jour—Dec. 23, 1899. No. 31495.

Precipitation.

Electrical Precipitation of Gold. Edgar Smart. Explains the principal features of the ore treatment process, and the apparatus used. 2800 w. Aust Min Stand (special)—June 1, 1899. No. 31-362 D.

Republic Mine.

The Republic Mine, Washington. M. H. Joseph. An account of this mine and the changes made during the past year. Ill. 3200 w. Eng & Min Jour—Dec. 16, 1899. No. 31396.

Victoria.

The Mining District. William Bradford. An illustrated account of its geological features, principal mines, systems employed, etc. 17000 w. Aust Min Stand (special)—June 1, 1899. No. 31-346 D.

IRON AND STEEL.

Armor Plates.

The Armor Plate Imbroglio. An extract from a memorandum prepared by Admiral O'Neil, discussing the advantages of the Krupp process and the advisability of a government armor-plate plant. 4000 w. Ir Age—Dec. 21, 1899. No. 31434.

The Manufacture of Armor-Plates at Sheffield. Illustrates and describes the Cyclops Works of C. Cammell & Co., Ltd. 3700 w. Ir & Coal Trds Rev—Dec. 15, 1899. No. 31615 A.

Blast Furnaces.

The Evolution of the Blast Furnace. A. H. Sexton. Extract from a paper read before the Phil. Soc. of Glasgow. Showing how modern methods of iron production are related to the ancient methods. 1400 w. Mines & Min—Dec., 1899. No. 31253 C.

The Youngstown Blast Furnaces of the National Steel Company. An illustrated detailed description of this new furnace plant. 4000 w. Ir Age—Dec. 21, 1899. No. 31433.

Furnace Gases.

See Gas Engineering.

German Opinions.

A German Expert View of the American Iron and Steel Industries. Translation from the *Berliner Tageblatt.* Concerning the signifiance of the commercial museum at Philadelphia. 1200 w. U. S. Cons Repts, No. 594—Dec. 4, 1899. No. 31-168 D.

Iron Manufacture.

The Development of Iron Manufacture in the United States in the Past Seventy-five Years. John Fritz. Full address delivered on the occasion of the celebration of the seventy-fifth anniversary of the Franklin Institute. History of the early developments in the United States. 8000 w. Jour Fr Inst—Dec., 1899. No. 31297 D.

Iron Ores.

Some Common Iron Ores. Considers varieties of the magnetites, hematites, and carbonates. 2200 w. Eng & Min Jour—Dec. 16, 1899. No. 31399.

Lake Superior.

Lake Superior Iron Mines. Dwight E. Woodbridge. An account of what has been done during the past year and the preparations for the coming year. Mines & Min—Dec., 1899. No. 31252 C.

Martin Process.

Improved Martin Steel Process. A. Sattmann, in *Stahl und Eisen.* Description, with illustrations showing the general arrangement of the plant. 2800 w. Col Guard—Nov. 24, 1899. No. 31-217 A.

Ohio.

The Iron Industry of Jackson County, Ohio. S. S. Knight. Gives history of this region, aiming to show its suitability for the location of blast furnaces—4000 w. Ir Age—Dec. 7, 1899. No. 31265.

Pig Iron.

Sandless Pig Iron. Thomas D. West. On the advantages of sandless pig iron. 2400 w. Am Mach—Dec. 28, 1899. No. 31631.

Steel.

Purified Open-Hearth Steel vs. Crucible Steel. Richard Moldenke. Reviews an article by Otto Thallner, in *Stahl und Eisen,* discussing the differences, and showing how an advantage is gained by remelting open-hearth steel in the crucible. 1800 w. Ir Trd Rev—Nov. 30, 1899. No. 31135.

Steel Pressing.

The Pressing of Steel; With Especial

Reference to Economy in Transportation. Henrik V. Loss. Describes a series of experiments giving a general view of the results. Ill. 2500 w. Jour Fr Inst—Dec., 1899. Serial. 1st part. No. 31298 D.

MINING.

Bitumen.

Phenomena Attending the Accumulations of Bitumen. A. S. Cooper. Describes phenomena observed in California. Ill. 1200 w. Min & Sci Pr—Dec. 2, 1899. Serial. 1st part. No. 31262.

Blasting.

Blasting by Electricity. Describes briefly the applications of electricity to methods of discharging explosives, discussing the advantages and disadvantages. 1500 w. Min & Sci Pr—Dec. 9, 1899. No. 31340.

Boring.

The Historical Development of Boring (Die Bohrtechnik in Ihrer Historischen Entwickelung). An address by Oberbergrat Tecklenburg, reviewing the development of deep boring for mining and prospecting. 3500 w. Glückauf—Dec. 9, 1899. No. 31545 B.

Caving System.

The Caving System of Mining. E. F. Brown. Illustrated description of the method employed in the Pewabic mine, at Iron Mt., Mich. 2500 w. Min & Sci Pr—Dec. 9, 1899. No. 31339.

Drilling.

Diamond Drilling. H. M. Lane. Notes on the different devices and methods used in drilling, showing the circumstances which necessitate their application and the dangers to be guarded against. 4400 w. Mines & Min. Dec., 1899. No. 31248 C.

Electric Power.

Electric Power Transmission in Mining (Die Elektrische Kraftübertragung im Bergbau). A. Bloemendal. Especially discussing the successful installation of polyphase plants in German mines. 4000 w. Stahl und Eisen—Nov. 15, 1899. No. 31593 D.

Electrical Transmission of Power in Mines. A. Bloemendal. From *Stahl und Eisen*. Illustrates and describes several installations, and discusses the advantages of the polyphase system. 3700 w. Col Guard—Dec. 1, 1899. No. 31336 A.

Fans.

Screw Fans. Charles H. Innes. Read before the N. E. Coast Inst. of Engs. and Shipbuilders. Illustrates and describes the methods of obtaining a reasonable efficiency of these fans. 700 w. Col Guard—Dec. 15, 1899. No. 31620 A.

Haulage.

Underground Haulage by Locomotives. M. J. Kersten. From a communication to the *Annales des Mines de Belgique*. Discusses the systems of haulage used when the mine workings are too sinuous for chain or rope haulage. Ill. 2500 w. Col Guard—Dec. 1, 1899. No. 31335 A.

Miner's Lamp.

The Storage of Electrical Energy and How It Affects Sparking. Sydney F. Walker. The writer's explanation of points brought out in a controversy with Mr. Halbaum on the subject of the comparative safety of the portable electric mining lamp. 2500 w. Col Guard—Dec. 15, 1899. No. 31619 A.

Mining Law.

An Important Tunnel Decision. Full text of the Colorado Supreme Court regarding the ownership of mineral where a tunnel site crosses prior locations. 17500 w. Min & Sci Pr—Dec. 9, 1899. No. 31338.

Victorian Mining Law. Joseph Woolf. Summary of statute law and regulations. 4000 w. Aust Min Stand (special)—June 1, 1899. No. 31358 D.

Ore Deposits.

Popular Fallacies Regarding Ore Deposits. Albert Williams, Jr. Some information of interest to miners of the precious metals. 1800 w. Can Min Rev—Nov. 30, 1899. No. 31154 B.

Progress.

Three-Quarters of a Century's Progress in Mining and Metallurgy. Charles Kirchhoff. Full address reviewing progress, delivered on the occasion of the celebration of the Seventy-fifth Anniversary of the Franklin Institute. 5000 w. Jour Fr Inst—Dec., 1899. No. 31296 D.

Pumping.

See Mechanical Engineering, Hydraulics.

Shafts.

Simultaneously Deepening and Lining a Belgian Colliery Shaft. Julien Linet. From a communication to the Assn des Engs. Sortis de l'Ecole de Liége. Illustrates and describes the work, stating the conditions. 2400 w. Col Guard—Nov. 24, 1899. No. 31218 A.

The Sinking of Shafts in Coal Measures (Approfondissement d'un Puits dans le Terrain Houiller). J. Linet. A description of a method of deepening the shafts of collieries and simultaneously lining them with monolithic walls of concrete. 4000 w. 3

plates. Rev Univ des Mines—Oct., 1899. No. 31575 G.

Siberia.

Auction of Siberian Mining Land. Details in regard to the leasing by auction of gold-mining territory. 2800 w. U. S. Cons Repts, No. 595—Dec. 5, 1899. No. 31166 D.

Timbering.

Colliery Timber and Timber Calculations. George Johnson. Shows the methods of calculating and discusses the usual practice in the timber trade in England. 2000 w. Col Guard—Dec. 8, 1899. No. 31417 A.

The Timbering of Shallow Veins (Ueber Den Abbau Schmaler Flötze). A description of the system which made it practicable to work veins 50 to 60 centimetres thick, with dips of 40° to 45°. 1500 w. Glückauf—Dec. 9, 1899. No. 31544 B.

Veins.

The Walls of Mineral Veins. Reviews opinions as to the relation of mineral veins to their walls, and gives conclusions of S. F. Emmons as to the origin of the Leadville ore deposits. 1500 w. Min & Sci Pr—Nov. 25, 1899. No. 31139.

Winding.

On the Relative Positions of Drums and Pulleys in Winding Arrangements. George W. Westgarth. Read before the South Wales Inst. of Engs. Gives information to determine the most economic lines, from a rope point of view, for the relative positions of the drum and pulley for pits from 100 to 1200 yards winding depth. 2700 w. Ir & Coal Trds Rev—Dec. 15, 1899. No. 31614 A.

MISCELLANY.

Aluminum.

Aluminum and Its Uses and Treatment. J. H. Henderson. Abstract of a paper read before the Manchester Junior Elec. Engs. Describes the methods of extraction, and its peculiarities as an electrical conductor. 1000 w. Ind & Ir—Dec. 15, 1899. No. 31612 A.

Bismuth.

Bismuth Ores in Tasmania. E. M. Weston. Part first describes the Belmont district as regards the local conditions and deposits. 1400 w. Aust Min Stand—Nov. 9, 1899. Serial. 1st part. No. 31448 B.

Graphite.

A Graphite Mine. R. H. Palmer. Describes the deposit in the town of Cranston, R. I., and its working. 900 w. Eng & Min Jour—Dec. 9, 1899. No. 31278.

High Temperatures.

The Goldschmidt Process for Producing High Temperatures (Ueber das Goldschmidtsche Schweissverfahren). A discussion of the results of experience with the use of aluminum for the production of very high temperatures. 1200 w. Glückauf—Dec. 2, 1899. No. 31543 B.

Nickel.

Nickel Mining in Ontario. Extracts from article in the *Toronto Globe* concerning the value of the product and arrangements for the development of the industry. 900 w. U. S. Cons Repts, No. 604—Dec. 15, 1899. No. 31384 D.

Ore Dressing.

The Progress in Ore Dressing. C. Blömcke. Translated from the *Berg- und Huttenmannisches Jahrbuch.* Describes the Lührig system as applied in modern mills,, discussing the advantages and disadvantages. 8500 w. Sch of Mines Quar—Nov., 1899. Serial. 1st part. No. 31647 D.

Rocky Mountains.

Gypsum and Clay. Arthur Lakes. The geological structure and economic values contained in the foothills of the Rockies near Loveland, Colorado. Ill. 2800 w. Mines & Min—Dec., 1899. No. 31255 C.

Separating.

The Development of the Magnetic Separator (Die Entwicklung der Magnetischen Aufbereitung). E. Langguth. A review of the history of early attempts to separate minerals by magnetism, and a discussion of the later methods applied in practice. 1800 w. Zeitschr f Elektrochemie—Dec. 7, 1899. No. 31562 G.

South Africa.

John Hays Hammond on the South African Situation. Chas. B. Going. An interview with the leading authority on the mines of the Rand, containing a fully authorized expression of his views of the present situation and the industrial future of the country. 3500 w. Engineering Magazine—Jan., 1900. No. 31585 B.

The Development of the Transvaal (Du Développement du Transvaal). G. Braecke. A carefully written account of the history and development of the mineral industry of the Transvaal, as seen from a Belgian point of view. 8000 w. Rev Univ des Mines—Nov., 1899. No. 31580 G.

Tin.

The Occurrence of Tin. A. Selwyn Brown. Describes the deposits in various localities, and some of the singular features. 1700 w. Aust Min Stand—Nov. 9, 1899. Serial. 1st part. No. 31449 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in October. Detailed list with classified summary and remarks. 5500 w. R R Gaz—Dec. 15, 1899. No. 31375.

Train Accidents in the United States in November, 1899. Detailed list and classified summary. 4500 w. R R Gaz—Dec. 29. 1899. No. 31629.

Fast Runs.

Another Record Breaking Train. An account of the runs of what is known as the "War Express," between London and Manchester, Eng. 700 w. Loc Engng—Dec., 1899. No. 31150 C.

Freight Movement.

Car Famines and Railway Terminals. On the delay caused by lack of facilities for unloading. 1400 w. Eng News—Dec. 21, 1899. No. 31463.

Speeds.

French and English Railway Speeds. Charles Rous Marten. Letter aiming to show that Mr. Burtt's comparisons were not quite fair. 1700 w. Transport—Nov. 24, 1899. No. 31230 A.

FINANCIAL.

Railway Systems.

Great Railway Systems of the World. A condensed statement giving much information. 900 w. Ry Age—Dec. 1, 1899. No. 31186.

Siberia.

Wages and Living on the Siberian Railway. L. Lodian. An account of the poor pay of Russian railway employees and how they live. Ill. 1400 w. Loc Engng—Dec., 1899. No. 31145 C.

LEGAL.

Pools.

Pooling of Locomotives. M. E. Wells. Extracts from a paper presented at Nov. meeting of the W. Ry. Club. Explains the working of the pool, and discusses its advantages. 1600 w. R R Gaz—Dec. 15, 1899. No. 31372.

Mr. Ripley on Pools and State Regulation of Railroads. A reply to the assertions of George F. Stone. Extract from paper submitted to the Congressional Committee. 1300 w. R R Gaz—Dec. 1, 1899. No. 31161.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Inspection and Maintenance of Air Brake Equipment. Discussion at the November meeting. 6000 w. Cent Ry Club—Nov., 1899. No. 31306 C.

Coal Cars.

The Canda 100,000-Pound Capacity Coal Cars. Illustrated description of the interesting features. 1200 w. Ry Age—Dec. 22, 1899. No. 31492.

Couplers.

Defects in Coupler Unlocking Gear. Editorial review of an interesting document sent out by the Interstate Commerce Commission. 1100 w. R R Gaz—Dec. 15, 1899. No. 31376.

Cylinder Power.

Cylinder Power of Compound Locomotives. G. R. Henderson. Discusses the ratio of tractive power to weight, showing the simple locomotive to have an advantage over the compound. 700 w. Am Engr & R R Jour—Dec., 1899. No. 31180 C.

Draft.

Draft Appliances and Extended Smoke Boxes. Editorial on paper by Snowden Bell, read before the Western Ry. Club, reviewing progress in draft appliances. 1500 w. Loc Engng—Dec., 1899. No. 31148 C.

Flange Wear.

Flange Wear of Car Wheels. Editorial discussing the increase in flange wear of late and the causes. 1600 w. R R Gaz—Dec. 22, 1899. No. 31458.

Locomotives.

American and Indian Built Engines. Photographs and description of American locomotives ordered for the Bombay-Baroda and Central India Ry. Also photograph and plan showing details of the first locomotives entirely constructed in India. 1800 w. Ind & East Engr—Nov., 1899. No. 31386 D.

American Locomotives for the Barry and Port Talbot Railways. Illustrated description of tank engines of English type, with some American features. 1000 w. Engr, Lond—Dec. 8, 1899. No. 31426 A.

A Pittsburg Standard Passenger Locomotive. Illustrated description of an engine recently built for the K. C., F. S. & M. Ry. 300 w. Loc Engng—Dec., 1899. No. 31149 C.

A Very Heavy Consolidation Engine for the Illinois Central. Full illustrated description of the 108-ton consolidation locomotive built by the Rogers Locomotive Works, of Paterson, N. J. 1700 w. R R Gaz—Dec. 15, 1899. No. 31374.

Colliery Locomotives. W. W. Clayton. From Trans. of the Institution of Min. Engs. Concerning their use and abuse, and the points that should be watched and what should be avoided in their construction. 2300 w. Mines & Min—Dec., 1899. No. 21256 C.

Compound Freight Locomotive (Locomotive Compound à Marchandises). Description and illustrations of heavy compound goods engine constructed for the Belgian State Railways. The weight is supported entirely on the drivers and the engines are to work on a grade of 3.12 per cent. 2000 w. Revue Technique—Nov. 10, 1899. No. 31509 D.

Consolidation Pushing Locomotive. Illustrated description of an engine for the D. & H. Co., using fine anthracite coal, and having an exceptionally powerful boiler for the weight. 600 w. Am Engr & R R Jour—Dec., 1899. No. 31182 C.

Locomotive Road Tests. W. H. Lewis. An interesting series of tests to ascertain the relation between the fuel consumption and the work performed. 2000 w. Am Engr & R R Jour—Dec., 1899. No. 31181 C.

Player Tandem Compound Ten-Wheel Passenger Locomotive. Illustration, with description, of a locomotive for high-class passenger service. 1300 w. Ry & Engng Rev—Dec. 9, 1899. No. 31310.

Rogers Locomotive for the Illinois Central. An engine of the consolidation type which is among the largest ever built. Illustration and detail drawings. 2000 w. Ry Age—Dec. 15, 1899. No. 31404.

Some Fundamental Distinctions in Locomotive Types. Editorial on the various types, the factors which enter into the selection of a type, and their limits. 1300 w. R R Gaz—Dec. 15, 1899. No. 31377.

Ten-Wheel Compound Freight Locomotives. Illustrated description of engines with piston valves on high-pressure cylinders, for use on the Northern Pacific Ry. 1200 w. Am Engr & R R Jour—Dec., 1899. No. 31179 C.

Lubrication.

Lubrication of Freight and Passenger Equipment. Discussion at the November meeting. 3300 w. Cent Ry Club—Nov., 1899. No. 31307 C.

Rail-Sawing.

Rail-Sawing and Drilling Car; Chicago, St. Paul, Minneapolis & Omaha Ry. Illustrated detailed description. 800 w. Eng News—Dec. 7, 1899. No. 31285.

St. Gotthard.

The Ventilation Plant for the St. Gotthard Tunnel (Lüftungs-Anlage für den Gotthard-Tunnel). A description of the Saccardo system recently installed at the Göschenen end of the tunnel. Diagrams showing the movement of trains and the velocity of air are given. 1800 w. 2 plates. Glaser's Annalen—Dec. 1, 1899. No. 31537 D.

Sanitation.

Railroad Sanitation. Abstract of discussion at the New England Railroad Club in Boston. Calls attention to some things that need correction. 2900 w. R R Gaz—Dec. 29, 1899. No. 31627.

Springs.

Stiffer Drawbar Springs. Claims that the strength of the drawbar springs should be increased in proportion to the increase in the tractive power of the locomotive. 600 w. Loc Engng—Dec., 1899. No. 31147 C.

Stays.

Crown and Cross Stays—Mexican Central. Illustrated description of the standard crown and cross stays used on this road. 700 w. R R Gaz—Dec. 29, 1899. No. 31628.

Steel Cars.

Economy of Mineral Transport. An illustrated article showing the present state of steel wagon construction in England. 4300 w. Ir & Coal Trds Rev—Dec. 1, 1899. No. 31333 A.

The Steel Car. An account of the development. 2000 w. R R Car Jour—Dec., 1899. No. 31337.

Train Heating.

The Heating of Railway Trains by Steam (Chauffage des Trains à la Vapeur). E. Belleroche. A discussion of the Lancrenon and Dery system, using mixed air and steam. 4000 w. 3 plates. Rev Univ des Mines—Nov., 1899. No. 31581 G.

Train.

The Alton Limited. Gives four fine plates illustrating the daylight limited train recently placed in service on the Chicago & Alton, between Chicago and St. Louis. 1200 w. Ry Age—Dec. 8, 1899. No. 31309.

NEW PROJECTS

Africa.

Railways of Africa. Map showing the extent of railway development, and a statement of the feeling in France concerning the demand for more rapid building of railways. 350 w. U. S. Cons Repts, No. 600—Dec. 11, 1899. No. 31295.

The Construction of the German East-African Central Railway (Der Bau der Deutsch-Ostafrikanischen Centralbahn).

A discussion before the German Railway Association giving an account of the proposed routes, with estimates of cost. 2000 w. Glaser's Annalen—Dec. 1, 1899. No. 31536 D.

Railway Schemes.

Railway Schemes in Parliament. Editorial discussion of schemes to be brought before the next session of the British Parliament. 5400 w. Engng—Nov. 24, 1899. No. 31207 A.

Siam.

The Railroads of Siam. Information concerning the roads built, and the need of new roads. 1300 w. R R Gaz—Dec. 22, 1899. No. 31456.

Transcontinental.

The Canadian Northern Railway and the Great Northern of Canada. Describes a proposed route across Canada. 1100 w. R R Gaz—Dec. 22, 1899. No. 31457.

PERMANENT WAY AND FIXTURES.

Boston Station.

The Mechanical Equipment of the New South Station, Boston, Mass. Walter C. Kerr. The various sections are described by those who designed them or were connected with the work. A full illustrated description of engineering appliances. 25800 w. Trans Am Soc of Mech Engs. No. 849—Dec., 1899. No. 31257 D.

Extension.

The "Boston and Providence Extension." An illustrated description of some of the problems in engineering in the extension from Huntington Ave., Boston, to the new South Terminal. 1400 w. R R Gaz—Dec. 8, 1899. Serial. 1st part. No. 31291.

Improvements.

Line Improvements on the New South Wales Government Railways. Illustrated particulars concerning improvements in permanent way and structures during the period of government ownership. 1300 w. Ry & Engng Rev—Dec. 9, 1899. No. 31313.

New York Central Improvements at Hoffman's, N. Y. Describes a connection made between the N. Y. C. and the West Shore railroads, to facilitate the use of the West Shore tracks. 900 w. Ry Age—Dec. 22, 1899. No. 31491.

Japan.

Railways in Japan. A résumé of the last annual report of the imperial Japanese railway bureau. 900 w. Cons Repts. No. 593—Dec. 2, 1899. No. 31124 D.

New Line.

The Construction of the Rutland Canadian Railroad. Map and description of a line under construction in the eastern part of the United States, 47 miles in length. 1000 w. Eng News—Dec. 21, 1899. No. 31464.

The Great Northern Railway. Illustrates and describes the new branch line and the goods station at Leeds. 1600 w. Engr, Lond—Nov. 24, 1899. No. 31214 A.

Peru.

The Central Railroad of Peru. Engravings and information concerning a road built under exceptional difficulties. 900 w. R R Gaz—Dec. 22, 1899. No. 31455.

Pittsburg Station.

The New Terminal Station of the Pittsburg & Lake Erie Terminal R. R. at Pittsburg, Pa. Burcham Harding. Detailed description of the engineering equipment of a very complete station. 2000 w. Eng News—Dec. 7, 1899. No. 31287.

Rail Deflections.

Investigations on the Temporary Deformations of Rails (Versuche über die vorübergehenden Formänderungen des Geleises). Alfred Birk. A résumé of experiments made upon the Vienna-Warsaw railway, with illustrations of the photographic recording apparatus employed. 5000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1899. No. 31532 D.

Rail Joints.

Clark Fisher's "Triple Fish" Rail Joint. Illustrated description. 800 w. R R Gaz—Dec. 8, 1899. No. 31294.

R. R. Building.

The Year's Railroad Building. A brief review of new construction in the United States during the year ending Dec. 31, 1899. 600 w. R R Gaz—Dec. 22, 1899. No. 31459.

Railroad Engineering.

The Lancashire, Derbyshire & East Coast Railway. Illustrated description of a line in Great Britain, especially interesting on account of the character of the country traversed and difficulties surmounted. 1100 w. Engng—Dec. 15, 1899. Serial. 1st part. No. 31616 A.

Signals.

Railway Signals. C. Francis Jenkins. Brief illustrated description of the "block system" and the latest system which is a combination of the manual and automatic. 1000 w. Sci Am—Dec. 9, 1899. No. 31258.

Yellow Signal Lights. Editorial, stating the considerations pro and con as taken by the N. Y., N. H. & H. R. R., and discussing the objections and advantages. 1400 w. R R Gaz—Dec. 8, 1899. No. 31292.

Soudan.

The Military Railway of the Soudan (Le Chemin-de-Fer Militaire du Soudan). A general description of the railway and a special discussion of the Atbara bridge. 2000 w. Revue Technique—Nov. 10, 1899. No. 31508 D.

Station.

Proposed Northern Pacific Station at Seattle, Wash. Illustration and ground floor plan, with brief description. 600 w. Ry & Engng Rev—Dec. 9, 1899. No. 31312.

Steel Ties.

Steel Ties in Mexico. Gives particulars concerning the design of the ties and the methods of maintaining track laid. Also states the advantages and disadvantages shown by experience. Ill. 1200 w. Ry & Engng Rev—Dec. 23, 1899. No. 31493.

Velocity Grades.

The Theory of Velocity Grades. Charles C. Wentworth. Mathematical demonstrations of the advantages in handling tonnage in connection with velocity grades. 1100 w. R R Gaz—Dec. 8, 1899. No. 31290.

TRAFFIC.

Paris Exposition.

Facilities for Handling Crowds at the Paris Exposition. Abstract translation from *Le Chemin de Fer*. Brief account of the arrangements being made for the transportation of the immense crowds expected. 1100 w. Ry & Engng Rev—Dec. 2, 1899. No. 31201.

Railways.

English and American Railways. A discussion of the American side. The present article considers rates and earning capacity, first cost, operating expenses, etc. 4200 w. Engr, Lond—Dec. 1, 1899. Serial. 1st part. No. 31343 A.

Rates.

The Railroads and the Farmers. W. M. Acworth. From the Trans. of the Surv's Inst., London. On the English rates for the conveyance of agricultural products. 1600 w. R R Gaz—Dec. 1, 1899. No. 31162.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Plan for the Introduction of Electric Power Upon the Berlin City and Belt Railway (Projekt über die Einführung des Elektrischen Betriebes auf der Berliner Stadt-und Ringbahn). A full account of the proposed change of the Berlin elevated railway from steam to electric power, with estimates of the cost. Also editorial. 10000 w. Elektrotech Zeitschr—Nov. 16, 1899. No. 31547 B.

The Berlin Underground Railway (Berliner Untergrundbahn). A brief description of the electric tramway between Treptow and the Silesia Railway Station. Excellent illustrations of the tunnel under the river Spree are given. 800 w. Ill. Zeitschr f Klein u Strassenbahnen—Dec. 1, 1899. No. 31577 D.

Bonding.

Cast Welding on the Calumet, Chicago. Illustrated description of the outfit to be used in cast-welding about 80 miles of track. 1800 w. St Ry Rev—Dec. 15, 1899. No. 31401 C.

Brake.

Eddy-Current Brake for Electric Tramways (Wirbelstrombremse für Strassenbahnwagen). Describing the improved device of the Helios Company, in which the electrical and mechanical brakes are united. 1200 w. Elektrotech Zeitschr—Dec. 7, 1899. No. 31556 B.

Buffalo, N. Y.

System of the International Traction Co., of Buffalo, N. Y. An illustrated description of the interurban lines, the Niagara Falls power equipment, stations, welded rail joints, etc. 5800 w. St Ry Rev—Dec. 15, 1899. No. 31400 C.

Car-Building.

Quality in Car Building. Discusses some of the false ideas in regard to cars and car-building, giving information on important points. 2500 w. St Ry Rev—Dec. 15, 1899. No. 31402 C.

Conduit Construction.

Electric Conduit Construction in Paris. A. N. Connett. An illustrated description of a construction differing quite radically from the usual, and using the side slot conduit. 3200 w. St Ry Jour—Dec., 1899. No. 31238 D.

Contact System.

The Kingsland Contact System. Illustrated description of a system to be soon tried at Wolverhampton. 800 w. Elec Eng, Lond—Nov. 24, 1899. No. 31229 A.

Earnings.

Transportation Earnings and Profits on Manhattan Island. Reviews the changes brought about during the last fifteen years, by which the lines have passed within the control of three competing systems, and the changes in traffic and increased earnings. 5200 w. St Ry Jour—Dec., 1899. No. 31243 D.

Electric Supply.

The Supply of Electric Energy for Traction Purposes. Philip Dawson. Discusses the best method of generating for this purpose, and the differences between lighting and traction, offering suggestions of value. 2500 w. Elec Rev, Lond—Nov. 24, 1899. No. 31221 A.

Electrolysis.

Electrolysis in American Cities. F. A. W. Davis. Read before the Central States Water-Works Assn., at Cincinnati. Illustrations of damaged pipe from various cities are given, with discussion of the remedy. 3400 w. Munic Engng—Dec., 1899. No. 31123 C.

Electrolysis of Cast-Iron Water-Mains. Lucien I. Blake. Calls attention to the dangers to cast-iron mains, even without the so-called electrolytic danger areas, illustrating by examples. 1300 w. Elec Wld & Engr—Dec. 16, 1899. No. 31408.

English Tramway.

The Manchester Tramway System. F. Brocklehurst. Explaining the system now existent, the steps taken toward municipalization, and the proposed expenditure. Ill. 3000 w. Tram & Ry Wld—Dec. 7, 1899. No. 31453 A.

Franchise Requirements.

Street Railways in Foreign Cities and Their Franchise Requirements. From a pamphlet issued by the Royal Trust Co. Bank, of Chicago. Ill. 2200 w. Eng News—Nov. 30, 1899. No. 31160.

Interurban.

The St. Louis & Belleville Electric Ry. An illustrated description of a well-built line. 1800 w. St Ry Rev—Dec. 15, 1899. No. 31403 C.

London.

The Tramway Policy of the London County Council. Clarence E. Ady. A sketch showing the importance of the operations and their far-reaching effect. 3500 w. Tram & Ry Wld—Dec. 7, 1899. No. 31454 A.

Manhattan Elevated.

The Manhattan System—What Electricity Will Accomplish. Burton Ellinwood Greene. On the advantage to be gained by electrical equipment. 1200 w. Elec Rev, N. Y.—Nov. 29, 1899. No. 31137.

Power Station.

The New Power Station for the Metropolitan Street Railway Company. Illustrated description of a station containing 11 engines developing 60,000 H. P., with accessory boiler plant, generators and minor apparatus for furnishing alternating current to the substations of 220-mile railway system, at which it will be transformed to direct current. The details of the building as well as the power plant are described. 6200 w. Eng Rec—Dec. 23, 1899. No. 31475.

Test of the Power Plant of the Capital Traction Co., Washington, D. C. Data abstracted from theses of graduates of Cornell Univ., prepared from results of tests made by them. 800 w. Eng News—Dec. 28, 1899. No. 31645.

Rapid Transit.

General Structural Details of the New York Rapid Transit Tunnel Railway. Illustrates the details as finally decided upon by the commission, with description of route and explanation of drawings. 2300 w. Eng News—Dec. 14, 1899. No. 31366.

Stray Currents.

Stray Currents and the Stability of Structures. Editorial, discussing the effect upon observatories, the Brooklyn Bridge and other structures. 2300 w. Engng—Dec. 8, 1899. No. 31416 A.

Subway.

Subway at Kingston, N. Y. Illustrated description of an interesting piece of construction work, by which a five-track grade crossing with a steam railroad is avoided. 1300 w. St Ry Jour—Dec., 1899. No. 31240 D.

Switzerland.

Important Three-Phase Electric Railway in Switzerland. Charles Rochat. Illustrates and describes the road connecting Burgdorf and Thun. 2500 w. St Ry Jour—Dec., 1899. No. 31239 D.

The Swiss Railway Between Burgdorf and Thun and Stanz and Engelburg (Die Schweizer Bahnen Burgdorf-Thun und Stanz-Engelberg). A discussion before the German Railway Association of two Swiss electric railways operated from hydraulic power and overcoming steep gradients. 2000 w. Glaser's Annalen—Dec. 1, 1899. No. 31535 D.

Transportation.

Mechanical Propulsion and Traction. G. Forestier. Part first considers animal traction, and the reasons for substituting mechanical, and the progress made. Ill. 4800 w. Auto Mag—Dec., 1899. No. 31132 C.

Underground Ry.

Will the Proposed Underground Railway in New York Pay? Describes the route, giving map, and also details of the project, discussing the financial requirements, etc. 2500 w. St Ry Jour—Dec., 1899. No. 31242 D.

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GOLD-MINING PROSPECTS IN RHODESIA.

By R. R. Mabson.

PRIOR to the granting by the British Government of a charter to the British South Africa Company (or, as it will be termed in any future remarks, the Chartered Company) the belief existed that the region north of the Transvaal and south of the Zambesi contained minerals in profusion, and especially gold. The country was visited by representatives of syndicates and individuals seeking concessions to search for minerals. Without going minutely into the history of the Chartered Company, it may be stated that its first objective was to secure mining rights over Mashonaland, and eventually, after a series of incidents recalling characters and events that would make a highly flavoured novel, Lobengula conceded rights to the initiators of the company and the charter was secured. An armed expedition proceeded to the Mashonaland field, establishing in its progress camps at Tuli, Victoria, Fort Charter, and Salisbury. One of the first administrative acts of the new company, after it had established itself and obtained the sinews of war in the form of share subscriptions, was to formulate a gold law, and various districts, principally in the neighbourhood of the north and west of Salisbury, were explored and areas were pegged out as gold claims. The area of claims at first was fixed at 150 ft. along the strike of the reef by 200 ft. each side, or in all 400 ft. across the reef outcrop. Subsequently—but this is a detail—the area was modified to 300 ft. each side of the reef, or 600 ft. across, the length on the strike of the reef remaining unchanged.

The initial idea was that, as mines were started, the Chartered Company, as ground landlord, was to get 50 per cent. of the vendors'

For the illustrations accompanying this article, we are indebted to the courtesy of the British South Africa Company. Mr. Mabson's paper sustains the interest in South African affairs which marked the contributions of Messrs. Albert Williams, Jr., H. G. Prout, and John Hays Hammond in recent issues of THE ENGINEERING MAGAZINE.

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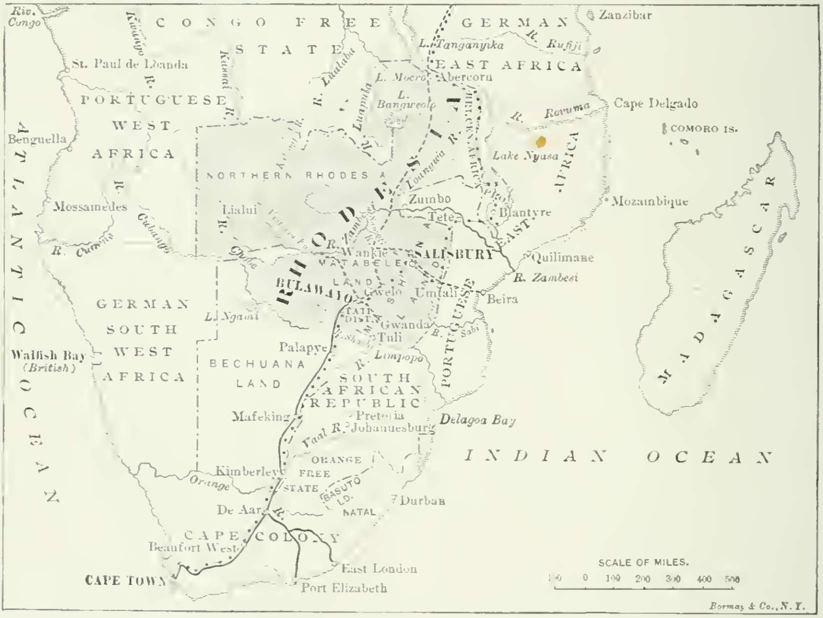
scrip; and, as the plan has been much referred to, a few words of detail may be given as to what the "50 per cent." really meant.

If it be assumed that a mining company were formed with a capital of £200,000, £150,000 being applied as scrip for the property and £50,000 for working resources, the outcome of the transaction would be:

Nominal capital, £200,000	To venders,	£75,000
	To Chartered Company,	75,000
	For working capital	50,000

In course of time the percentage was modified, and in recent times an average of about 30 per cent. has been handed to the Chartered Company on like procedure to that set out above.



MAP OF RHODESIA AND ADJOINING PORTIONS OF SOUTH AFRICA.

Exploration companies owning large areas scattered over the country proceeded to development, found likely areas, formed sub-companies to mine, and the scrip proportion was in respect of the latter class of company. The big exploration and landholding companies occasionally did a "deal" with the Chartered Company, and compounded for any sub-flotations of mines by handing it an agreed proportion of the exploration company shares.

Ab initio, the Chartered Company has had the backing of a large

EARLY TRAVEL IN RHODESIA.

section of the public, both in Great Britain and on the Continent—about the beginning of 1899 it had more than 40,000 shareholders, and some 10,000 of them Continental holders. It has had likewise not a few adverse critics—the latter either believing or professing to believe that the public was being deceived, or holding forth that it was sinful to take over and civilise a country that had till the end of the nineteenth century been *terra incognita.*

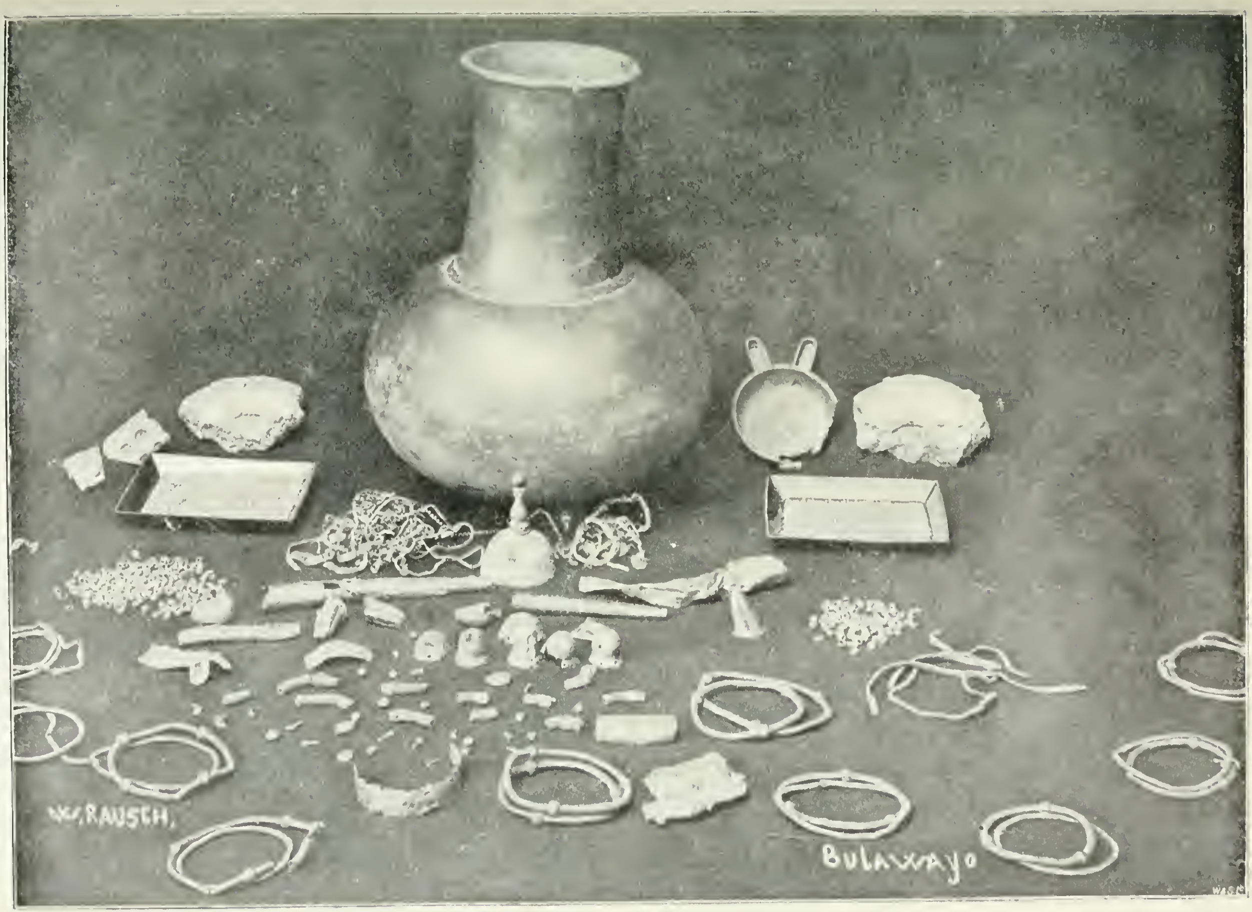
Taken from the business point of view, while a great number of persons credited the assertions as to the existence of payable gold propositions, a great number professed the entirely opposite belief. Many, indeed, went so far as to say that no gold whatever existed. Subsequently, on proof being afforded by actual experience that there was

TRAIN ON THE LINE TO BULAWAYO.

gold, assertions were made that, though there might be gold, there was no gold in payable quantity. Not, indeed, until late in 1898, when a start was made on an extended scale in milling gold, were the original pessimistic theories dispelled. But this is going a little in advance of events. The vehement assertions of the non-existence of gold were for a long time supported by the fact that year after year passed without its production. The first property pegged out bore date 26 Sept., 1890. That property, and in round figures approximately 90 per cent. of the properties which were pegged out subsequently, were selected by the original prospectors for the reason that they contained "old workings." Prospecting operations were greatly facilitated over large stretches of country by the discovery of excavations, about which a great deal remains to be ascertained. It has been maintained that some of the excavations were made by the ancient Phœnicians. Remains of buildings have been discovered in which gold ornaments have been found, and those buildings are believed to date, in some instances, from three thousand years ago. They certainly were never constructed by the ignorant black population.

A GROUP OF NATIVES.

The evidences have been too numerous and palpable for close observers of the gold industry to credit assertions that the enormous ancient pits and stopes, existing in Rhodesia, were other than man's handiwork. Furthermore, mining operations have completely dispelled the vehement assertions that have at times been made that, even granted the excavations have been effected by ancient diggers, all the gold had been extracted. The disproof of this has been ample.



GOLD ORNAMENTS FOUND IN ANCIENT RUINS, RHODESIA.

SALISBURY FROM THE KOPJE.

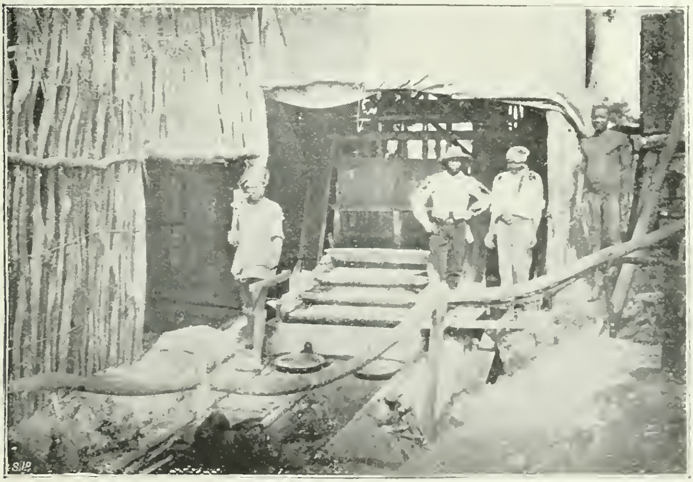
PIONEER STREET, SALISBURY.

IN THE MATOPPO HILLS, SOUTHERN RHODESIA.

A TRANSPORT WAGON IN PIONEER DAYS.

Geological experts who have visited the country have repeatedly announced that the lodes are true fissure veins, *i. e.,* that the gold-bearing reef continues indefinitely into the ground. It is to be recollected that the ancient miners, even if but decades instead of centuries ago, had only primitive appliances for working. When they delved into the earth they attained, so far as I could learn, (and I visited some fifty developed properties during my journeyings through the conutry.) the utmost depth of about 250 ft. and perhaps an average depth of

LOBENGULA'S BATTERY, UMFULI RIVER.



LOBENGULA'S FIVE-STAMP BATTERY, HARTLEY, 1892 some 100 ft. In the Geelong mine—which by the way is in Matabeleland, south-east of Bulawayo—the greatest depth was attained. Now at depths varying from 100 to 250 ft. from the surface oxidation ceases. The action of the air over countless centuries disintegrates the pyrites and makes the gold contained in the ore far more readily treated than is the case below a zone of, say, 100 to 250 ft., where the sulphide ore is come upon.

ANCIENT STOPE, GEELONG MINE.

The cessation of work by the ancients may be put down to three causes. Taking the Geelong mine for example, first, it may be that at such depth as 250 ft., water was an insuperable obstacle in the absence of pumping appliances; next, it may be that, even were the mine dry, when the workers passed from the oxidised to the sulphide zone they came upon ore from which, with their rough appliances, they could not extract the gold; thirdly, work may have been stopped by the wholesale massacre of the workers. This is the explanation generally accepted. Be this as it may, the first two suggestions are quite sufficient to account for the lode being followed only to a comparatively slight depth. But this leads to the next point—refutation of the statements that the gold was all worked out, and that that was the reason why no further depth was attained. This theory will not hold water for an instant, and for this reason. Reverting to the Geelong mine, which is very typical: at the time of my visit to the property in June last, I found the shaft on the incline of about 45 degrees had been carried down very nearly 600 ft. The deepest old working, as I have mentioned, was 250 ft.; consequently, gold-bearing ore was being mined and milled which was derived from a depth of, say, 300 ft. below the deepest of the old workings.

It may be convenient here to mention the further evidences of operations having been conducted in the old workings which for a time were alleged by some theorists to be only nature's handiwork. When I went into the Geelong ancient stopes (which are left intact) I spent a considerable time fossicking about at depth. My object was to see, as far as I could, the traces of man's handiwork. I was perhaps better able to discern points which might have escaped the ordinary observer from having, as a pastime, studied the evidences of flint implements of prehistoric man in the British Isles.

I was happy, in turning over the débris, in coming upon two granite balls, bearing evidences of having been used as hammers, almost exactly round and about the size of the two hands clenched. In parts, the ancient stopes were very narrow, and one had to penetrate to cavities [stopes] of not more than two or three feet from roof to footwall. In other parts the stopes were quite cavernous. In the latter, the wall was frequently alcove in character, smooth, and in parts still black from smoke, and amongst the débris were remains of charcoal. It is believed (and I can quite credit the theory) that the procedure of the ancients was to light fires in the stopes, and then, when the gold-bearing rock cooled, to use granite hammers to break down the ore. To go further, the chipped-off gold-bearing rock would probably be put into native baskets and carried to the surface. Though not noticeable at the Geelong, at other mines—the Bonsor, the Red and White

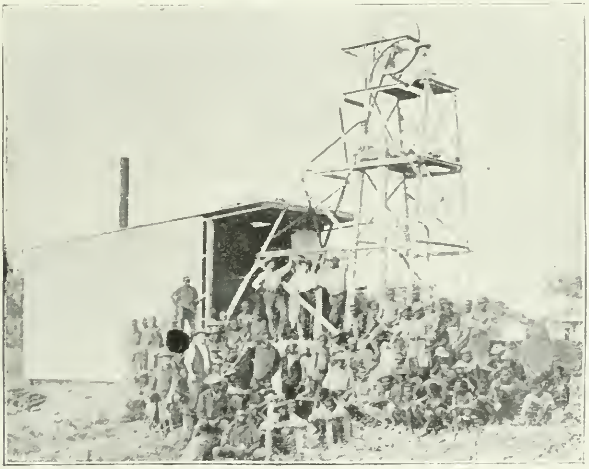
BATTERY SITE, GEELONG MINE.

Rose, and one or two others—I found occasionally at the top of kopjes, or little hills, where there were large masses of hard rock, patches of indentations in flat areas of rock, just as though mortars had been sunk into the rock. I was shown, on some properties, smaller granite stones picked up in the vicinity of the rock pots. One can imagine the women bearing baskets of broken ore from the mine to the top of the kopje, where other women were seated crushing the ore with the granite balls in the pots. Beside the pots were numerous slight elongated indentations, recalling those which the verger at Canterbury Cathedral shows to visitors as having resulted from the scraping of soles of pilgrims' feet when they genuflexed at the shrine. It would seem from other rock implements of grinding character that the indentations were made in the process of grinding the rock flakes into a powder, after the rock, roughly broken out in the stopes, had been broken up small.

How did the ancients ultimately extract the gold? The answer to this is that, in nearly all cases, mines are near pools or streams, and frequently by the sides of these bodies of water are found rock pots somewhat similar to those found on the kopjes. We can imagine that the powder was deposited in these rock pots, flushed with water, the sand driven off, and the gold, sinking to the bottom, was eventually collected. Even in the present days, one can buy, in Portuguese territories, little quills containing gold flakes and dust.

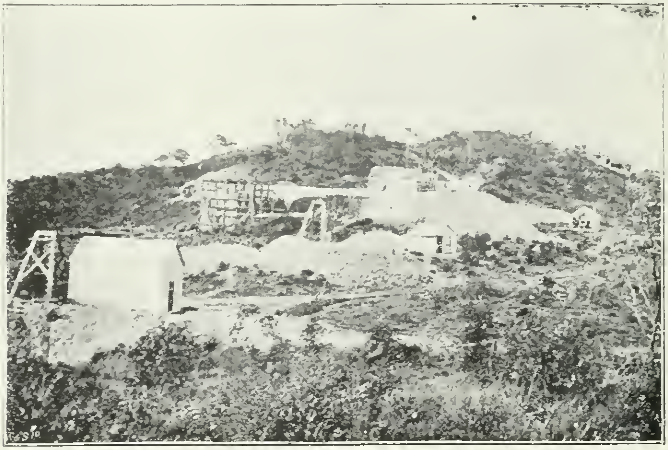
We may now return to the history of gold production in Rhodesia. From 1889 to 1898 is a long period to elapse before the stage of commercial production is reached, especially in these days of Anglo-Saxon energy. The long delay was in part due to the fact that there was more disposition to speculate in gold-mining shares than to settle down to hard work, though it will be noticed the first property was only selected late in 1890. A great number of companies were formed at the time of the granting of the charter to the British South Africa Company, or shortly afterward. In order to comply with the gold law and secure title, a certain amount of work had to be done in a given time. The original prospectors pegged out claims, sought soft spots on which to sink shafts—generally in old workings—attained a depth, in the average, of about 80 ft., proved the existence of gold, and disposed of their properties to capitalists, who in turn floated companies. Extravagant prices in shares were sometimes paid for properties; other shares were issued for working capital; but the proportion between working capital and purchase price was generally far too one-sided, and the outcome was inadequate resources for development. Moreover, just when the companies were reaching the stage of setting seriously to work, came the struggle between the whites and Lobengula's hordes, necessitating the withdrawal of whites from the mines, their concentration, and the advance from Mashonaland into Matabeleland. This was in 1893. A great number of the men who had devoted themselves to the exploitation of Mashonaland, when they reached what they conceived to be a land of greater promise, stopped there. Mashonaland for several years was all but deserted, and the new field of Matabeleland alone had energetic attention given to it. There was a repetition of the process of fossicking, pegging, provisional development, and flotation.

The region east and south-east of Bulawayo was found to contain larger and richer reefs than those in Mashonaland around Salisbury. In especial was this the case in the Gwanda field, one hundred miles south-east of Bulawayo, in the Sebakwe, about fifteen miles north of Gwelo, and the Selukwe, a like distance south of Gwelo. In the Gwanda field are situated the Geelong, having a reef averaging 15 ft. thick, and Nicholson, with double reefs, one of which has been developed to such an extent as to prove that for a long stretch it contains reef west of the river averaging 30 ft. and running up to more than 50 ft., and east of the river averaging 50 ft. and running up to more than 60 ft. wide. This is one of two parallel reefs. Further east of the river the continuation of the reef has been ascertained quite recently to expand to a width of about 100 ft. and assays have led experts to offer the opinion that an extraction of ½ oz. of gold to the ton will be

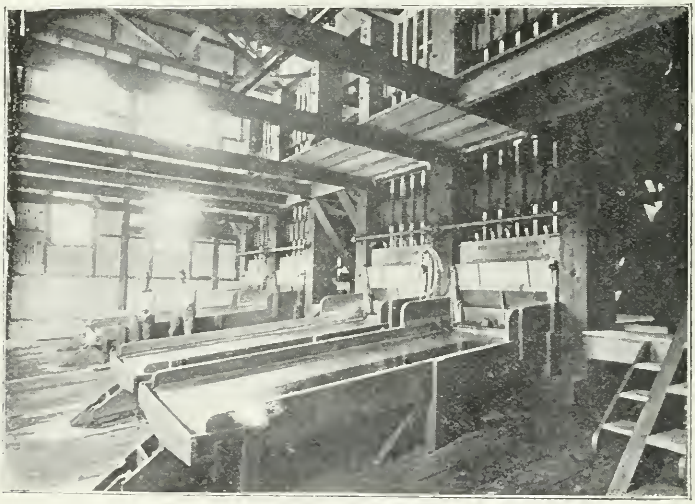


VULTURE REEF, GWANDA DISTRICT.

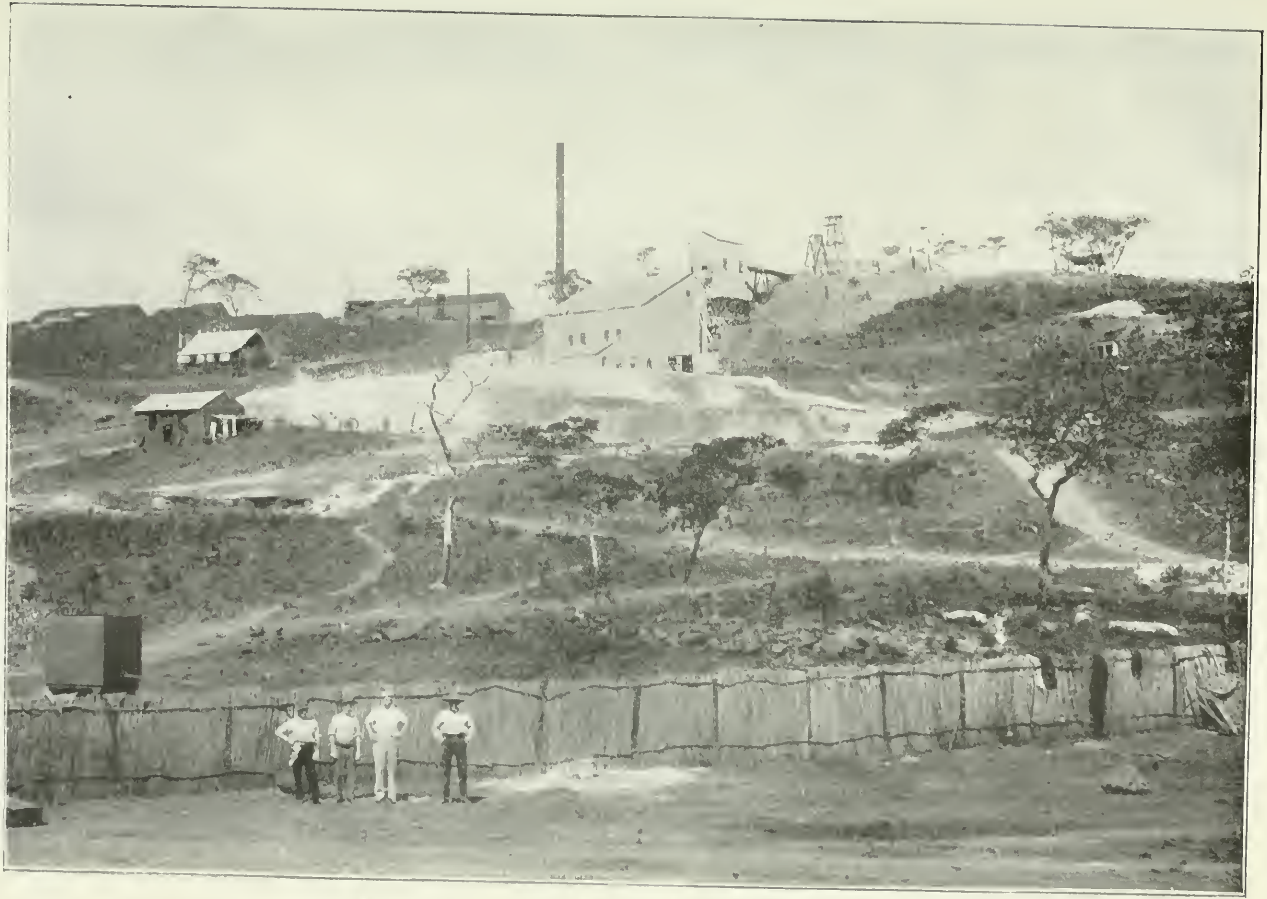
secured. The line of the reef extends for miles. In the Sebakwe district is the Globe and Phœnix mine, on the eve of making a start with its mill. There, for a stretch of about 1,250 ft. there is a rich chute of ore, averaging about 19 in. in width and showing assays of nearly 3½ ozs. to the ton. This is the show mine of the field, but there are other mines being opened up in the immediate vicinity. To the south of Gwelo, the Selukwe (or, as it used to be termed, Tebekwe) mine has shown very rich results and has been largely developed. Near it are the Bonsor and the Dunraven properties.



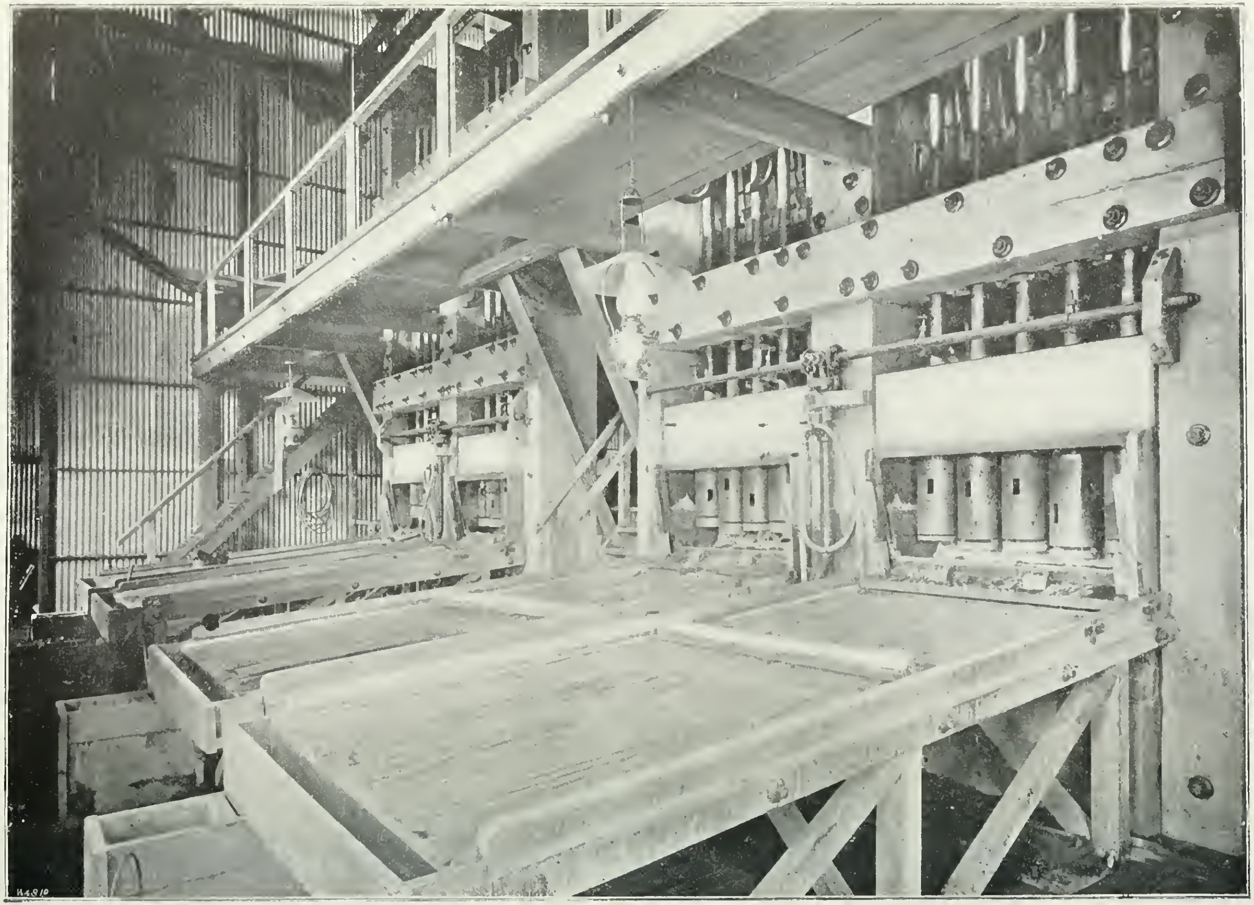
ANTENIOR MINE, GWANDA DISTRICT.



DUNRAVEN BATTERY.



GENERAL VIEW OF TEBEKWE MINE, SELUKWE GOLD-MINING CO.



INTERIOR OF BATTERY HOUSE, TEBEKWE MINE, SELUKWE GOLD-MINING CO.

Milling results have lately been given by the Geelong and Antenior, in the Gwanda district; the Selukwe, Bonsor, and Dunraven, in the Selukwe district; and the Globe and Phœnix, in the Sebakwe district. All these mines, doubtless, would have become producers at a much earlier stage than late in 1898, but for the fact that Matabeleland, like Mashonaland in 1893, had in 1896 a native trouble, and prior to that trouble there was the terrible scourge of the Rinderpest—a scourge which has scarcely been appreciated outside of South Africa. For instance, I went over one farm in Matabeleland, where, prior to the outbreak of rinderpest, there were eight thousand branded cattle. When I was there in 1899 there were only eighty small imported cattle, chiefly from Madagascar. Oxen, in the old days, used to provide the sole mode of transport. The rinderpest plague broke out early in 1896, and when it was at its worst as to demoralisation of the natives the Matabele rising occurred. The second native trouble broke out in March, 1896, and the white population, outside of centres like Bulawayo and Gwelo, had to concentrate at these points, and mining was necessarily temporarily abandoned.

HEAD GEAR, GLOBE AND PHOENIX MINE, SEBAKWE.

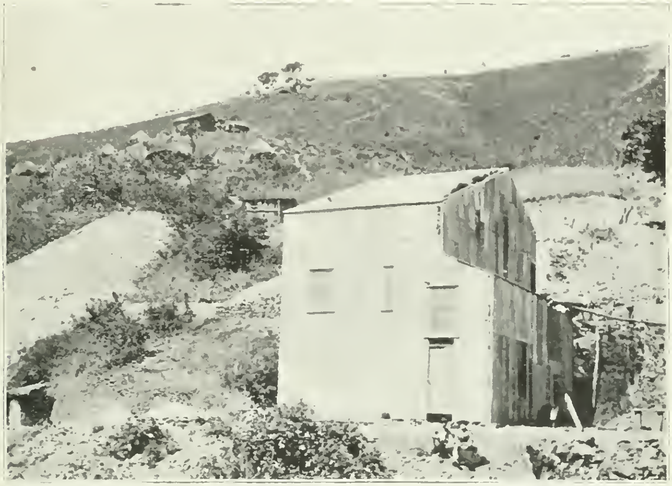
Rhodesia, as a whole, is patchy as to geological characteristics, granitic and schistose formations alternating. One encounters stretches of granite country, with wearisome "roads" of loose disintegrated granite sand, and emerges from such a tract into a schistose red-earth country. The gold areas are almost exclusively in the schistose formation.

The intermittent areas of schistose ground extend over a very large mileage—quite three hundred miles in a trend from north-east to south-west, and from one hundred to one hundred and fifty miles from south-east to north-west.

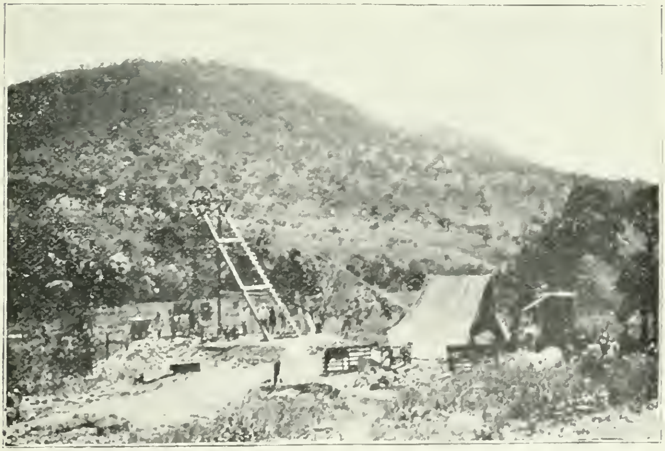
In one of Mr. Rhodes' addresses to the shareholders of the British South Africa Co.—in May, 1899—that gentleman mentioned that the total number of claims which had been registered in Rhodesia exceeded one hundred and thirty thousand. As I have stated, approximately nine claims out of ten have been selected because of the existence on them, or near them, of ancient workings. Were the claims on the run of the reef *i. e.,* 150 ft. each claim—placed side by side in one continuous line, such claims would reach about as far as from Chicago in a direct line to London.

HEAD GEAR, CHRISTMAS REEF.

In Rhodesia, as in America, mining companies are permitted to "follow" the reefs through all the dips, angles, and spurs. This is not the case in West Australia nor in the Transvaal, where one can follow the reef only to the extent of the surface ground and cannot mine beyond the limit of a vertical line sunk from the frontier of the surface. The difference in the procedure of mining under the Transvaal and the Rhodesian law means something very considerable. With the reef inclining into the earth at an angle of about 30 degrees, and continuing indefinitely, one Rhodesian claim containing the outcrop of the reef, and followed to easily practicable mining depth, would give the right to extract from a reef of 3-ft. thickness, about 222,000 tons. The same surface area of a Transvaal mine under like conditions of dip and thickness would give the enterprise under the Boer law a right to extract less than 12,000 tons. What, then, may be expected from claims in Rhodesia like those found to exist in the Gwanda district, having a reef 15 ft., 30 ft., 50 ft., or even 100 ft. thick?



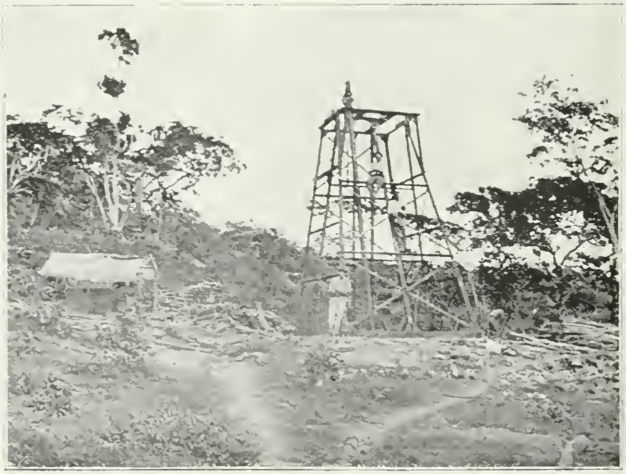
PENHALONGA BATTERY, NEAR UMTALI.



CHRISTMAS REEF, NEAR BULAWAYO.

There is not in Rhodesia, as in the Transvaal, the same eagerness to secure what is termed "dip ground." As pointed out, in the Transvaal the area containing the outcrop of the reef alone can be mined under by the company having possession of property in which the reef outcrops. Beyond the frontier of such area, any company which wishes to tap the continuance in depth of the same reef has to acquire the portion of ground adjacent to the outcrop area, sink a vertical shaft, come upon the reef, and work it. A third or a fourth company of like "deep" character may secure ground in which, at further depth, the reef may exist. With the ability of Rhodesian miners to "follow" the reef indefinitely, acquisition by companies has been confined to ground actually containing, or believed to contain, the reef outcrop. Given that, of about 3,700 miles along outcrop claims, only 5 per cent. contain payable reef, the possibilities as to the future of Rhodesia are enormous.

We have many proofs, in widely separated districts, that the reefs are payable—proofs as instanced twenty miles north and about twenty miles south of Gwelo, and proofs from approximately seventy miles almost due south to a point one hundred and twenty miles south-east of Bulawayo. The run of the reefs in the latter district indicates an almost uninterrupted continuance for a distance of about twenty miles, from the Antenior mine with paying mill results, on the west, to the Geelong mine with like paying results on the east; and beyond, south-east of the Geelong some ten miles further in the same trend, are the Nicholson reefs.



AYRSHIRE MINE.

There has been no call so far for prospectors to search for reef formations in virgin ground. Hence so small a proportion of what has been selected as reef-bearing is of virgin character. The ancients were good fossickers, but it is conceivable that many areas containing reef escaped their notice.

A deterrent to the mining industry in the past has been the want of transport facilities. Bullock-wagon transport has been costly and slow, and indeed the sending of boilers and heavy machinery in some districts was not attempted, owing to the huge expense. Railway construction, however, is greatly facilitating the equipment and supply of mines. The bulk of the heavy work has been effected since the opening, in November, 1897, of the railway from Cape Town direct to Bulawayo, and the Salisbury district in May, 1899, was connected by railway via Umtali with Beira on the east coast. Early in 1899, arrangements were entered into for building a line of one hundred miles from Bulawayo to the Gwanda gold district, and it will be extended to Tuli to tap the coal area there. Again, from Bulawayo in a north-easterly direction a road is being built to Gwelo to give access to the districts in that vicinity. Surveys are now being made for a road to connect Salisbury via Gwelo with Bulawayo. There is also a railway projected from Bulawayo to the coal and timber areas north-west. The railroads mentioned will all be of standard 3 ft. 6 in. gauge, and the probability is that feeder light lines to mine districts will be built in course of time.

CONSTRUCTION WORK ON THE MASHONALAND RAILWAY.

Given restoration of peace to South Africa, rapid strides in the settlement of Rhodesia and extension of mining will be witnessed. Fresh reef discoveries are constantly being made; more energy was being shown prior to the war disturbance than perhaps at any time in the history of the country; and capitalists in Europe were showing greater inclination than has been apparent for several years to put up cash for mining and railway development, when there came the check of progress through the Transvaal trouble. So far, there is nothing phenomenal as to richness; as usual, occasional nuggety specimens, but no especially rich deposits as in West Australia or Colorado; but the outlook is for a steady progress to be made, and in Southern Rhodesia there are possibilities of some properties proving capable of being dealt with by mills of large size. For mining, there are three essentials—fuel, water, and timber. Hitherto, wood fuel alone has been used, and the timber in vicinity of producing or even developing mines will be exhausted in a short time. Happily the country contains coal deposits—both in the south, near Tuli, and say one hundred and thirty miles north-west of Bulawayo—to both of which points there is the promise of early railway facilities. In winter water is difficult to obtain, and so far very little has been effected in the direction of conservation. In summer there is everywhere superabundance, but it has been permitted to flow away from spruit to stream, and by the numerous rivers into the sea. Judicious expenditure on dams and reservoirs would give abundant supplies for the dry season. The same difficulties were experienced on the Rand and were overcome. Though, as previously observed, the country generally has only small timber, there are large areas of forest land with trees of considerable size—in especial of a tree which is of most useful character, as the white ant—a scourge of the country—will not touch it.

RAILWAY BRIDGE OVER THE SHASHI RIVER, THE SOUTHERN BOUNDARY OF MATABELELAND.

FUNCTIONS AND ORGANIZATION OF THE PURCHASING DEPARTMENT.

By Hugo Diemer.

THE functions of the purchasing department in a manufacturing establishment may be stated as follows:

First:—To secure the most satisfactory material.

Second:—To secure the most desirable delivery of the material.

Third:—To obtain the best terms of payment and lowest prices.

The order in which these functions are mentioned will appear to be, on reflection, the order of their relative importance.

The successful accomplishment of the first function demands that the purchasing agent shall be a man who has a working knowledge of the particular industry for which he is to buy material. If he has, in addition, a knowledge of the fundamental principles of the strength of materials, of metallurgy, and of machine design, so much the better, for he will be able to make practical application of such knowledge.

That the purchasing agent be the possessor of practical manufacturing knowledge is just as essential in an establishment which refers its tests of materials to a testing laboratory, or to its engineering department or superintendent, as in a smaller establishment which does not conduct such tests. If care is exercised to obtain a man of the qualifications indicated, to fill the position of purchasing agent, there will be far less liability to the error, frequently made, of buying material good enough in itself but not exactly adapted to the particular purpose for which it is desired.

It is assumed, at the outset, that persons other than the purchasing agent will have specified the exact physical or chemical properties of the articles that are the most important constituents of the manufactured product of the establishment. But there is no manufacturing process so simple that it does not require the purchase of a great variety of minor articles, the examination of each one of which by the engineering department would be a useless burden. And it is here that the purchasing agent's training and experience come into active play.

To salesmen, the ignorant, affable young clerk who has been promoted to the position of purchasing agent is a familiar type. He is frequently the cause of a salesman's prolonging his stay in a city several days, until finally he sees the man with whom he can have an intelligent conversation. It is quite evident that, where this is the case, the young man is a hindrance from an economic standpoint, since the additional cost of sales departments on account of prolonged stays is sufficient to increase materially the unnecessary expense connected with the placing of an article on the market.

The securing of the most desirable delivery involves a knowledge of business methods and forms in which, unfortunately, purely technical or shop men have generally had but little training; and this fact is the excuse for the common practice of appointing, as purchasing agents, clerks who have had but little technical or shop knowledge.

A thoroughly systematic conduct of the office, such as is absolutely essential to insure the proper attention to this very important matter of delivery, is much facilitated by the use of certain forms. It is not my present plan to give any set forms, as forms of any kind must be modified to suit the requirements of any particular case. There are some fundamental principles, however, which have stood the test of time in a number of cases, and can well be applied in almost any factory.

It is very customary for foremen to lay the blame for delays in manufacture upon delays in receipt of material. Hence it is of the utmost importance that foremen be compelled to put themselves on record by making requests for material in writing. This provision must form a part of every thorough system designed to provide for the prompt supply of material and supplies.

Where it is at all possible, a shop should be divided into departments, these departments being, for the sake of simplicity, designated as "Section A," "Section B," etc. The foreman in charge of each section should have his requisition book, the requisitions being numbered separately for each section; for instance, those for section "A" should be numbered "A 101," etc., those for section "B," "B 101," etc. For convenience in rapid assorting, the requisition blanks for the respective sections may be printed on paper of different shades of color.

The foreman's requisition is best made in triplicate, one copy going to the store-keeper, and one copy to the purchasing agent. I have frequently heard it offered, as an objection to the introduction of the system mentioned, that a section foreman is too busy to write requisitions. And yet, where this claim was made, I have seen the foreman walk a long distance to the store-room to make a verbal request for supplies, stopping a while to gossip, and perhaps forgetting what he started for; whereas, if his request had been put in the form of a requisition, he would not have had to leave his department, and the request would have been put permanently on record.

It is often a good plan to have the store-keeper determine the quantity of material required, the foreman's requisition calling simply for the article, and the store-keeper filling in the amount. This system of shop requisitions for supplies will be found to be advantageous in securing quicker manufacture, even where there is a "Production" department to provide for ordering the bulk of all material entering into the manufactured product. Where such a production department exists, the shop requisitions will, of course, have a tendency to narrow themselves down to factory supplies and tools. But, in addition, the requisitions will serve as urgent requests for delayed material.

As to the form in which the purchasing agent's order is issued, it is a matter of surprise to me to find that many large establishments are still using the old-fashioned stub-book for orders, necessitating an enormous waste of time in indexing. The indexing is entirely done away with by having purchase-orders typewritten with two additional carbon copies. One set of carbon copies (numbered, of course, consecutively, the same as the original orders), is filed in alphabetical order of the names of the parties from whom goods are ordered, a punch file being used. If a firm has a great many purchase orders, extra-long prongs may be used on the punch file and several different boards may be used, each file-board containing only a part of the alphabet. This method of filing serves the same purpose as an index, and has the enormous advantage of being a system in which the unfilled orders may be kept on file by themselves, something utterly impossible where the old-time stub-book system is used. If desired, an extra set of carbons may be filed according to the consecutive numbers of the purchase-orders; or the original purchase-orders may be copied into an impression copying-book in numerical order. This is usually a superfluous labor, however, as the alphabetical files of completed and uncompleted orders will be found entirely sufficient for reference. As soon as a purchase order has been completed it is taken off the file-board containing uncompleted orders and put onto the file-board containing uncompleted orders, under its proper alphabetical letter, the orders under each letter being arranged according to their numbers. It is well to note dates and amounts of invoices on the orders as they are taken off the incomplete files.

The second carbon copy of the purchase-order (which may be made with a different color of carbon paper—say red or green, to distinguish it from the other copy), is sent to the store-keeper, or to the receiving clerk if he is a separate official, for his guidance on the arrival of material. The shop requisition number should be entered on this carbon copy before it is sent to the receiving clerk. Some shops attain this same result by having a perforated stub attached to the foreman's requisition, the purchasing agent writing his purchase-order number on this stub and then sending it to the receiving clerk.

A simple method of securing promises of delivery is to enclose a printed post-card acknowledgment of order, with blank for promise of delivery, with each purchase-order where a promise of delivery is desired. To keep track of promises it is very convenient to have a set of thirty-one pigeon holes, each pigeon hole representing a day of the month, and each hole containing memoranda of shipments promised for that day. This affords a systematic method of stirring up delinquent shippers, the number of promises being noted on the memoranda as they are transferred from one pigeon hole to another. Where an establishment is situated in a large city and many orders are local, it is best to separate the city orders from the others so that they can be followed up by telephone instead of by mail. For this purpose it may be well to have a separate series of purchase orders for local use distinguishing them by some convenient prefix letter. A pigeon-hole file as indicated can be run through once a week, on a regular day. It will be found very useful in hastening deliveries of material.

As to the third function of the purchasing department, that of securing good terms and low prices, much depends upon the shrewdness and tact of the purchasing agent. Courteous attention to salesmen is always desirable, and can be accorded without loss of time if nothing but strictly business conversation is indulged in.

The mere request for a little more liberal cash discount than is usually given will frequently result in its being allowed, and the same is true of securing deferred payments where that is desired. The cash-discount system, if applied to all purchases, however small, will result in a considerable annual saving. It is well worth remembering that it is on small purchases that cash discounts are usually allowed.

The card-index system for recording prices has become so generally used that it is hardly worth while to speak of it. I have found, however, that it will be most satisfactory to have two separate price indexes, one for goods actually bought and the other for quotations.

It is very desirable that the purchasing department report daily the cost of all material received and an accurate estimate of the cost of all material ordered, noting approximately the date at which the goods ordered must be paid for.

All of the above systems can be successfully conducted by a purchasing agent with a competent stenographer as assistant, and he will need no other help if his orders do not exceed fifty or sixty a day.

THE FUTURE OF ELECTRICAL SUPPLY.

By Alton D. Adams.

STEAM-DRIVEN electric plants are finding their ultimate development in the service of great areas through sub-stations. Concentration of generating equipment in a single plant has resulted from economies by this means made possible in the items of labor, fuel, water, and transportation. Sub-stations are necessary for purposes of reducing and regulating pressure, supplying diversity of service, and distributing direct current. In the main generating plant are installed the smallest practicable number of large, direct-connected engines and dynamos, which develop alternating current at high pressure. From these high-voltage dynamos, cables are laid direct to the sub-stations, located at short intervals over the service area. The alternating current of high pressure is reduced in voltage, changed to direct current, and delivered to the distribution system by means of transformers, rotary converters, motors, arc dynamos and batteries at the sub-stations. Main stations, generating current at high voltage for delivery to sub-stations, whence it may be distributed at low voltage, were first introduced for the supply of electric lamps and stationary motors, but the system is gradually and surely extending to the operation of electric railways.

Electrical supply was inaugurated some years ago with a station equipment of boiler, steam engine, and dynamo, and, as above noted, the current-generating, transforming, and distributing machinery has increased to three and even four times the rate of energy output. In addition, the length, weight, and cost of transmitting and distributing conductors, per unit of electric supply, has multiplied several times. These great additions to electrical equipment have resulted from the requirements of steam-power generation. The systems of electrical supply take form, in large measure, from the nature of the prime mover on which they ultimately depend. Economy in steam-power production involves the largest practicable production of energy at a single point; this necessitates that service be made to consumers at long distances from the main plant. Supply of electric energy over a considerable distance becomes impracticable, through the cost of conductors, unless comparatively high pressures are employed. Such pressures are not expedient for delivery at the consumers' premises, or at the motors of electric cars; hence the requirement for sub-stations. For transmission between main and sub-stations, a single kind and pressure of electric current is desirable; for the supply of consumers a variety as to form and pressure of electric energy is necessary. To transform in pressure and convert in quality requires machinery with capacity of two or three times the actually delivered energy. The cost of conductors for transmission between stations is a clear addition to that for local distribution. An ultimate system of electrical supply having been evolved to meet the exigencies of steam driving, it remains to consider whether this system will survive the passing of its prime mover. The answer to this question must turn largely upon the comparative advantages of the electric system and the new motive power.

In the simplest form of electrical supply, the dynamos at the generating station furnish current directly to the distribution system, and there is no transforming equipment between the power plant and the consumer. In such a station, the entire output of the dynamos, save a small loss in distribution lines, is available at the consumers' premises. The investment, therefore, in electrical machinery includes one kilowatt capacity for each kilowatt delivered to distribution lines. In an electrical-supply system of the latest type, for the service of a large area, the output of dynamos or rotary converters at the sub-stations represents the delivery capacity of machine equipment to distribution lines. The energy output of the main electric generators, per unit delivered to local distribution lines, depends on the number and character of the intermediate devices. The simplest common arrangement of the main and sub-station system includes dynamos at the generating plant, and transformers and rotary converters at the sub-stations. A high figure for the efficiency of the rotary converters is 90 per cent., and of the transformers 95 per cent., under average conditions. These figures give a combined efficiency in operation of $90 \times .95 = 85$ per cent., and, allowing a loss of only 5 per cent. in the lines between the main and sub-stations, there will be only $.85 \times .95 = .80$ of a kilowatt delivered to the distribution lines for each kilowatt output at the steam-driven dynamos. Taking the capacity of rotary converters as 1, that of transformers is $1 \div .9 = 1.11$, and of main dynamos $1.11 \div (.95 \times .95) = 1.23$, so that the combined capacity of electrical equipment per kilowatt output is $1 + 1.11 + 1.23 = 3.34$ kilowatts. The main-and-sub-station system of electrical supply, which the conditions of economical steam-power development make necessary for the service of large areas, requires, therefore, an investment in electrical machinery of more than three times the capacity equivalent to the useful output. It demands, also, expensive transmission cables between stations, while it delivers to distribution lines only about 80 per cent. of the electrical energy developed. This is about the best showing that can be made for the ultimate electric system with steam drive. In many sub-stations, a part of the energy sent out is derived from the main supply by the use of transformers, motors, and dynamos, thus further increasing the cost of equipment and lowering the total efficiency below the point just stated. Storage batteries play an important part, as to pressure regulation and maximum-load capacity, in sub-stations and in many generating plants where dynamos are connected directly to distribution lines. As the action of batteries has no important bearing on the questions here considered, however, figures concerning them are omitted. So long as the steam engine continues to be the best available prime mover, the main-and-sub-station system of electrical supply over large areas, for light, power, and street-railway service, seems to offer the best possible solution.

Another form of prime mover has, however, for years been growing in importance, now rivals the steam engine, and may in the future largely displace it, by reason of superior economy in fuel. This new motive power is the gas engine. Recent developments in gas-engine practice and in the production of fuel gas have demonstrated an efficiency for the combined producer and engine, in brake horse-power hours per pound of coal consumed, which is much better than the best performance of the steam boiler and engine. In a small plant containing a gas producer and two engines, each under 100 horse-power in capacity, tests have shown the consumption of anthracite buckwheat coal to be only 1.03 ℔s. per i.h.p. hour. About the best figures that can be obtained for the consumption of a more expensive grade of coal, in large steam plants with compound condensing engines, are 1.5 ℔s. per i.h.p. hour, or 50 per cent. more fuel than was required in a gas-engine test. The figures just noted for fuel consumption with gas engines are by no means isolated ones, similar results having been obtained in many cases. On large gas engines a higher rate of power production per hour has been obtained per unit of fuel, as in one case of a 320-h.p. engine, where an indicated horse-power was produced with a consumption of .81 ℔. and a brake horse-power on 1.03 ℔s. of coal per hour. A reduction of one-third of the fuel now consumed in the best steam-power plants certainly furnishes a large inducement to substitute gas engines, and there seems to be no corresponding disadvantage to offset the higher economy. The first cost of gas engines is not far from that of compound steam engines with condensers, and feed-water heaters, high-class boilers, and attachments cost but little less per unit than do fuel-gas producers. The requirements of the gas-engine-and-producer plant are not more exacting as to fuel transportation and water than in an equivalent steam-power station, and the labor item for the same output is no larger. There is good reason to think, therefore, that the steam engine, having reached the maximum efficiency of which it is capable, through its range of temperature, will gradually be displaced by the gas engine.

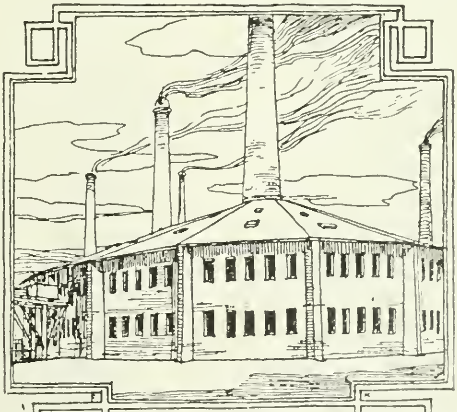
The electrical-supply system for a great area, including one generating station and many sub-stations, will certainly be at an advantage over its present condition when equipped with gas producers and engines requiring only about two-thirds of the coal now consumed under the steam boilers. The large investment and losses in electrical lines and machinery remain, however, as before, and it remains to discover whether these items can be reduced. Evidently, the additional electrical equipment of the main-and-sub-station system, beyond that of the old arrangement with several generating plants, can only be eliminated by replacing transformers, electric motors, and rotary converters with prime movers and dynamos at the sub-stations. This does away, of course, with the single, large, power stations, and is, to a large extent, a return to earlier practice. The system with a number of small generating plants is known to be uneconomical, when steam is the motive power, but the gas-engine equipment may be able to meet the conditions. It would be possible to equip a number of comparatively small gas-producer-and-engine plants, over a large area of electric service, and operate them at a greater economy, as to fuel consumption, than can be attained in the best steam-driven station of any size whatsoever. The room required for these small producer-and-engine plants, the costs of water and of fuel transportation, also that of extra labor, would render them decidedly inferior to a single large gas-producer and electric-generating station distributing to sub-stations on the present plan. The conclusion seems certain that the gas-generator plant, like the steam plant, is at a great advantage in point of economy when conducted on a very large scale, at a single point.

There remains but one other alternative to be considered; since the gas should all be generated at a single point, is there any decided advantage to be gained by its distribution to sub-stations through pipes and its use at these sub-stations in engines driving dynamos which supply lines direct? Such an arrangement will dispense entirely with transmission cables between main and sub-stations, will reduce the complete capacity of electrical machinery to its actual delivery into distribution lines, or to less than one-third of that required in the system of main and sub-stations, and will lower somewhat the total gas-engine capacity, by avoiding the transmission and the transforming losses. Allowing the dynamos in sub-stations an efficiency of 90 per cent., the energy developed by the gas engines is only 1.11 times that delivered to distribution lines, instead of 1.23 times as in the main-and-sub-station system. As no labor for the operation of engines is now required at the plant where the gas is generated, and as the operation of engines at the sub-stations will take little more attention than did that of the electrical machinery there displaced, the labor item may be considered constant. Sub-stations with gas engines and dynamos occupy little, if any, more space than with the present electrical equipment. Water for cooling gas-engine cylinders must be provided at sub-stations, but the automatic devices now available to cool water make it possible to reduce the supply to the amount lost by evaporation. The only additional item of equipment necessary in a system with sub-stations operated by engines, supplied with gas from a single generator plant, is that of pipes to convey the gas. Radiating from the gas producer of such a system there might well be, for an average case, from ten to twenty large gas mains, laid directly to the several sub-stations. Each of these gas mains should, of course, be large enough to supply its sub-station at periods of maximum load. To compare the investment for a system of electrical supply, in which current generated at a main station is transmitted to the sub-stations by insulated cables, with a system in which gas from a producer plant is piped to engines at the sub-stations, only the items peculiar to each method need be considered.

Though the system with electrical transmission between main and sub-stations includes greater losses from gas engines to supply lines than does the system where the gas itself is transmitted, the smaller engines needed for sub-stations may cost a little more per unit, so the total engine investment may be considered constant, whether at the main or sub-stations. Rotary converters at the sub-stations cost somewhat more than dynamos of the same output to replace them, but, yielding a little to the complete electric equipment, the first outlay may here again be held to be equal. Assuming that only transformers and rotary converters are necessary at sub-stations, though motors and dynamos are in some cases required, the excess in electrical machinery, in the case of the system with main power-generating plant and insulated transmission-cables to sub-stations, includes the main dynamos and the transformers. The transmission cable is peculiar to the complete electric system, the gas mains to the plan with gas engines at sub-stations. In either case the distribution conductors should be the same, and the use of batteries at sub-stations remain constant. The investment in main dynamos, transformers, and transmission cables on the one hand should, therefore, be set against that of the gas mains on the other.

A comparison of these items can best be made from the conditions of a specific case. As the sub-stations each present the same problem, differing mainly as to distance and capacity, a consideration of one will be sufficient. A practical size of sub-station may be selected from present practice at 300 kilowatts or 400 h.p. capacity, and a practical distance of five miles from the electric-generating or the gas-producing plant may be assumed. As above shown, the main dynamos in the electric-transmission and distribution system must have a capacity for 1.23 times the rate of delivery by the rotary converters, so that a supply of 400 h.p. to distribution lines at the sub-station, batteries not being considered, requires dynamos at the generating plant of 400 × 1.23 = 492 h.p. capacity. The output of transformers at the substation, as above shown, will be 400 × 1.11 = 444 h.p. Allowing an installed price of $25 per h.p. for the main dynamos and $10 per h.p. for the transformers, their combined cost for the delivery of 400 h.p. by the rotary converters is (492 × 25) + (444 × 10) = $16,744, or $16,744 ÷ 400 = $41.83 per delivery capacity to distribution lines. A pressure of 6,600 volts has been adopted in several important instances for the dynamos at a main generating plant supplying a number of distant sub-stations, and may fairly be taken for this case. To transmit 492 h.p. a distance of five miles, in the form of electric current at 6,600 volts, and at a loss of 5 per cent., requires an outlay for insulated cable and tile conduit of approximately $10,000, exclusive of laying, or $10,000 ÷ 400 = $25 per h.p. delivery capacity to distribution lines. The total outlay for machinery and cables peculiar to the all-electric system is, therefore, the sum of $41.83 + $25 = $66.83 per h.p. delivery capacity to rotary converters at sub-stations. With dynamos having an efficiency of 90 per cent., driven by gas engines at substations and delivering 400 electrical h.p. to distribution lines, the engine must develop 400 ÷ .9 = 444 h.p. Allowing 100 cu. ft. of producer gas for engine consumption per brake-horse-power hour, the rate of gas supply must be 444 × 100 = 44,400 cu. ft. per hour during periods of maximum load, provided that no considerable storage capacity is provided at sub-stations. The cost of a pipe five miles long to deliver gas at the rate just named, with a friction loss of 5 per cent. of the power produced by the gas, is about \$26,400, or \$26,400 ÷ 400 = \$66 per electrical h.p. delivered for distribution. This item for pipe does not include the cost of laying, which may be left to offset the cost of laying the electric cable and conduit, not computed in the other case. This large charge for pipe would be very much reduced with a gas of high heating capacity, like that used for illumination, of which only about one-fifth the bulk would be required to yield the same energy.

Comparing the two systems of electrical supply above described, it seems that the first cost of the complete equipment is about the same for each case, but the complete electric system is somewhat less efficient. The combined efficiency of the main dynamos, step-down transformers, transmission line, and rotary converters is .90 × .95 × .95 × .90 = .73, while the combined efficiency of the gas main and the dynamos at the sub-station is .95 × .90 = .85. The system which places the gas-engines at sub-stations, while costing no more for the first investment, delivers .85 ÷ .73 = 1.16 times as much of their output for distribution as does the system with all the engines at a main station.



STEAM-ENGINE BUILDING IN SWITZERLAND.

By A. Stodola.

HE who travels through Switzerland, although but a tourist, admiring the marvellous beauties of its natural scenery as a layman in mechanical matters, must perceive the abundant sources of water power everywhere available. The numerous hydraulic-power plants, situated upon the principal rivers at points where streams pour down from the mountain clefts, bear silent witness of the direction in which the efforts of Swiss engineers have been principally employed. When the traveller discovers further that Switzerland possesses almost no iron, and no coal at all, he will be doubly astonished to learn that this land holds a pre-eminent position in the art of steam-engine construction, in the building of machines whose very existence depends upon the possession and use of coal.

Switzerland itself, however, is no insignificant user of steam power, when its small area is taken into consideration. Already the rapid growth of its manufacturing and transportation industries is outstripping its water-power facilities. In the late 70's the city of Zürich erected what was at that time considered a very large hydraulic plant, intended to supply power for manufacturing at low cost. Since then the increase in population has been so rapid that an auxiliary steam plant of 3,000-h.p. capacity has been found necessary to supply the immediate demands for light, power, and water-supply; while the original plans for the development of a special industrial quarter, served with power by wire-rope transmission from the hydraulic-power plant, have proven altogether inadequate.

The city of Winterthur, with all its important metal-working industries, uses only steam power, and the same is true of Basle, where the great chemical color works are situated; for the immediate future

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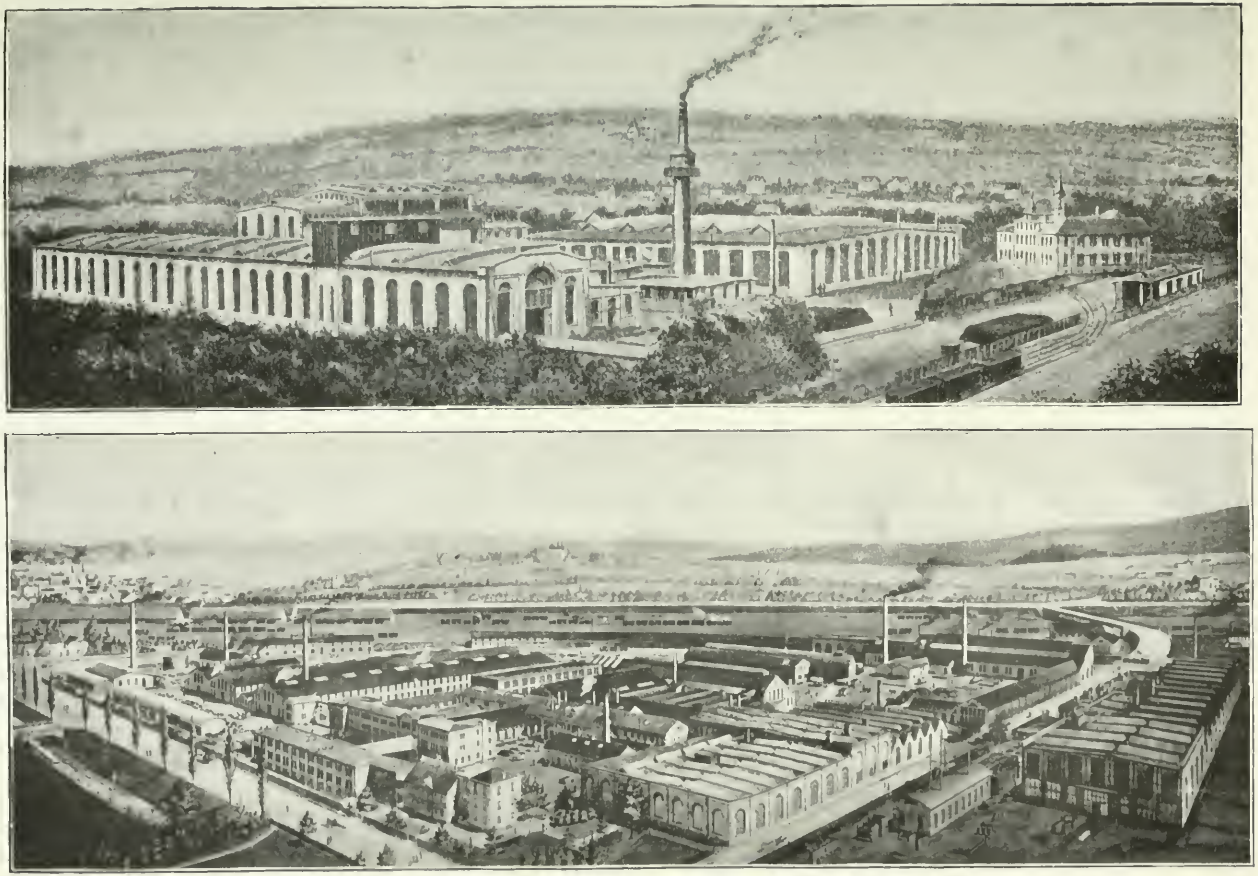
The last few years have been marked by an amazing advance in the range and in the total of power applications—an advance of which the most striking feature has been the constant interplay and mutual reaction of increased use and improved economy. The tendency everywhere has been toward rapid growth in the size of prime-mover units, and recent events have made international comparisons of practice very valuable.

Prof. Stodola's clear and able review is founded upon his intimate acquaintance with the Swiss industry—practical construction as well as theory and design. It was prepared by special request for The Engineering Magazine, and is here presented in translation from the original German. Owing to lack of time, the translation has not had the benefit of the author's revision.

It will be of particular interest in connection with Mr. C. A. Hague's contribution on "The Steam Engine for the Electric-Traction Power House," published in this Magazine, December, 1899, and January, 1900, and with the forthcoming papers by Prof. Gutermuth. on German steam-engine building, and by Mr. Philip Dawson, on the contrast between English and American steam-engineering practice.—The Editors.



TWO GREAT STEAM-ENGINE BUILDING WORKS OF SWITZERLAND.

The upper cut shows the establishment of Escher, Wyss & Co., Zürich, the lower the machine-shops and foundry of Gebrüder Sulzer, Winterthur.

it is evident that nearly all industries must look to steam as the most available source of motive power.

According to the report of the Swiss Steam-boiler Users' Association, the number and distribution of steam boilers at the close of 1898 was as follows:

Industry.	No. of Boilers.	Heating Surface.
Textile Industries	1,054	443,150 sq. ft.
Food Supplies	663	162,514 "
Chemical Industries	183	83,635 "
Metal Industries	373	115,700 "
Woodworking	353	79,146 "
Paper Mills	126	59,222 "
Steamboats	172	108,200 "
Water Works and Electric Plants	52	30,968 "
Special and Miscellaneous Industries	935	247,236 "
Totals	3,911	1,329,771 sq. ft.

These figures will enable a general idea of the steam-power in Switzerland to be obtained, it being understood that the boilers of the steam railways are not included in the above table. The growth of steam plants in the future, however, must be expected to be much more rapid, since the new factor of competition with electric transmission must be considered. It is well known that since the famous transmission of electric power from Lauffen to Frankfort was accomplished, electric-transmission plants have become extensive in Switzerland. Electrochemistry has appeared as a great user of power, demanding constantly increasing investments of capital for the construction of great electric-power stations, supplying many chemical works with energy. Examples of projects now under consideration are found in the scheme to take 20,000 h.p. from the Rhine for use in the Canton of Zürich, and in the plan to obtain 60,000 h.p. from the valley of the Etzel for distribution to large and small consumers. A continuance or a possible increase in the price of coal, otherwise an actual calamity, will doubtless cause these projects to be put into immediate execution, and so we may soon see Switzerland divided up into centres of power, distributing the energy of the streams to the neighbouring country. Some provision must be made for the intermediate spaces which must remain between the areas thus supplied with power, and this doubtless will be by the use of steam power. Another factor in the further introduction of the steam engine is found in the limitations which have made themselves felt in the utilisation of hydraulic power. In many instances it has proved necessary to provide a large reserve steam plant for use in case of insufficiency of the water-power, when such a reserve was not at all considered in the original design. If the very large dimensions required for hydraulic motors for low heads be considered, and the later experience in the effects of climatic changes be consulted, the former estimates of the cost of hydraulic power may have to be materially revised.

The last factor with which the steam engine has to contend in its struggle for existence is the use of the gas engine as a prime mover, especially in the use of Dowson or producer gas. The enthusiastic efforts of many advocates of this system, however, have somewhat abated since it has been demonstrated that in the great majority of cases only coke or anthracite coal can be used in such gas-producers, and the predictions that lignite and inferior coals could be advantageously used still remain unfulfilled. The inability of the gas engine to stand temporary forcing above its ordinary capacity is a defect in this class of motors, while a slight falling-off in the quality of the gas makes a marked difference in the efficiency. In several instances of gas-engine plants for operating electric tramways, the capacity has been underestimated some 10 to 20 per cent., requiring enlargement to be made at much inconvenience, the reserve motors being compulsorily operated continuously while the stations were being enlarged. Nevertheless, Dowson generator plants are very numerous in Switzerland, and in Baden, Zürich, Oerlikon, Lausanne, Romanshorn, Berne, Uster, and St. Gall there are gas-power plants for lighting or for tramway driving, in addition to a large number of private installations. The most important plant is at Basle, where more than 1,000 h.p. are generated by means of Dowson gas. The popularity of this process is due to the general use of anthracite coal in Switzerland. The great distance of the coal districts, and consequent high transport charges, render it desirable to use the best quality in the most economical manner, and this has led to an extensive introduction of Belgian anthracite. The cost of coal and its increasing price will be appreciated when it is understood that the best coal from the Saar and Ruhr Districts cost 320 to 350 francs per car of 10,000 kilogrammes a year ago, while at the end of December, 1899, the price had risen to 450 to 480 francs, the latter price corresponding to about $9.40, or 39s., per long ton.

All these conditions indicate that the building of steam engines in Switzerland will no longer remain what it has mainly been up to the present time—an export industry. In such case, however, its characteristic position will in no wise suffer and the industry, skill, and intelligence devoted to it will doubtless raise it to a position still higher than that which it occupies at the present time.

The cost of engine building in Switzerland is affected not only by the high cost of shipment of the completed work, but also by the fact that nearly all the principal raw materials, especially coal and iron, must be imported from other countries. Wage conditions, also, are certainly not more favourable than those existing in the works of her great competing neighbour, Germany. The Swiss workmen stand as high in respect to their standard of living and home comforts, as any of their fellow workmen on the Continent or in England; I can make no comparisons with conditions in America. The dwellings of the Swiss workmen are certainly a degree better than those of the same class in other countries, and all the conditions of life have been strongly influenced for the better by the constant stream of foreign travel, due to the natural attractions which have made Switzerland a terminal for travellers from all countries furnishing examples which have reacted upon the standard of comfort of the whole population. It is only necessary to point to the great institutions for the sick (hospitals), and to the united beneficial and accident associations; which associations in the near future will probably acquire such a legal status as may materially affect industrial conditions.

Under conditions already so difficult and constantly growing more difficult, the establishment of Gebrüder Sulzer, of Winterthur, was founded in the year 1834 by the brothers Johann Jakob and Salomon Sulzer. They were the pioneer steam-engine works of Switzerland, destined to become famous throughout the entire world and to exert a powerful influence over Swiss engine-building. Beginning with a small iron foundry and machine shop at Winterthur, they at first employed only twelve men. From this small beginning grew the present great establishment, which, with the branch establishment at Ludwigshafen, in Germany (founded in 1881) employs more than four thousand workmen, and has constructed more than four thousand two hundred steam engines, aggregating over half-a-million horse power. It is an interesting fact that the grandfather of these two brothers, in the latter part of the 18th century, conducted the business of a metal founder, and that his numerous descendants still follow either the industrial or commercial side of the same business.

The special feature of the work of the firm of Gebrüder Sulzer is found in the wide scope of technical effort early undertaken and fully developed to an extent productive of remarkable consequences. In the year 1866, when the fame of Corliss first began to be known in Europe, Gebrüder Sulzer commenced the manufacture of the poppet-valve engine which they have since brought to such a high degree of perfection. The tubular double-seated valve had, indeed, been known before this time, but had not been considered capable of competing with the Corliss valve. Since that time, however, the name of Sulzer has been identified with the development of the steam engine in Europe much in the same manner as that of Corliss is known in America. The relative advantages of the poppet and Corliss valves have been discussed so often that it is not necessary to go into that part of the subject here. The claim of both types as to correctness of action and durability have been fully demonstrated for many years past by the successful increase in speeds and reduction in steam consumption in a great number of installations, and by the successful application of superheated steam. As a consequence of the increased number of revolutions and greater steam pressures demanded by modern practice, the double-seated valve has, in some instances, been replaced by a four-seated one. This is accomplished by the combination of two double-seated tubular valves, one above the other, the dimensions depending upon the quantity of steam flowing through them. By this arrangement the lift of the valve need be only one-half that otherwise required, thus also diminishing the drop to the same extent, and reducing the weight of the moving mass and lessening the strains upon the levers. The introduction of the four-seated valve is the latest con-

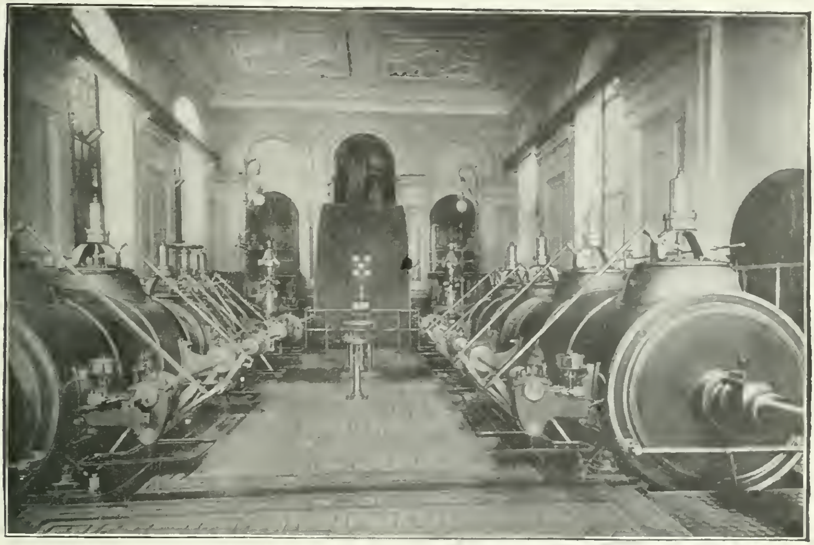


FIG. 1. TRIPLE-EXPANSION ENGINE WITH TWO LOW-PRESSURE CYLINDERS.

Normal capacity, 1,800 h. p. Built by Gebrüder Sulzer, of Winterthur, Switzerland, and installed at the Nikolski Manufaktur Savva Morosoff's Son & Co., Moscow, Russia.

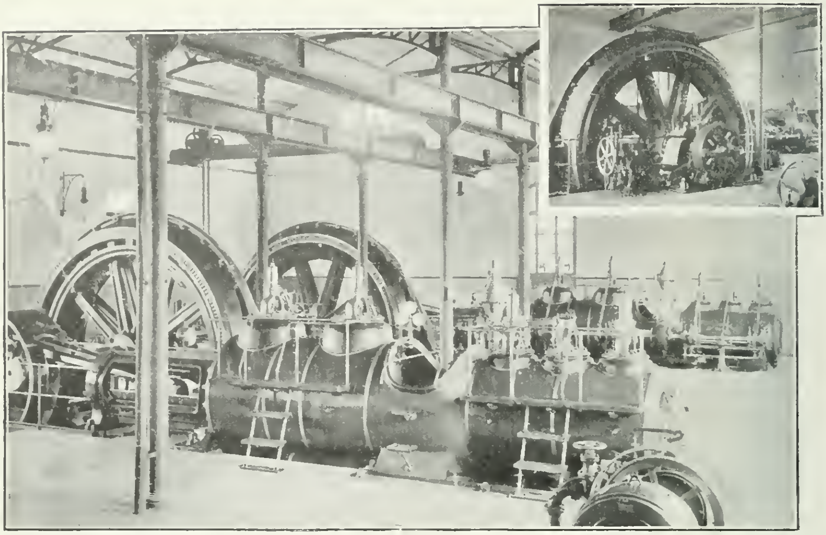


FIG. 2. HORIZONTAL COMPOUND ENGINE, ZÜRICH, SWITZERLAND.

Built by Gebrüder Sulzer, Winterthur, and peculiar in having the low-pressure cylinder nearest the crank-shaft. Normal capacity 1,000 h.p.

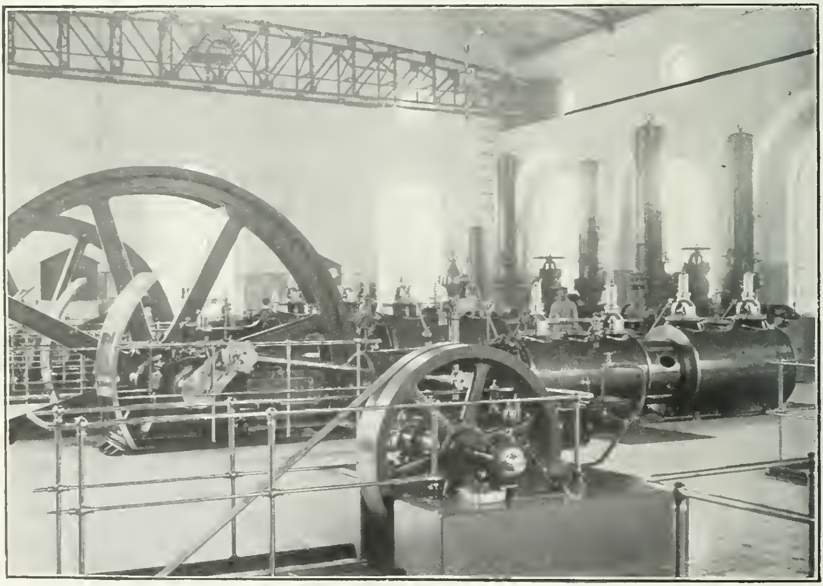


FIG. 3. TRIPLE-EXPANSION PUMPING ENGINES AT ST. GALLEN, SWITZERLAND.

Built by Gebrüder Sulzer, Winterthur; pumping against a head of 1,082 feet. This engine showed under test, a thermal efficiency of 12 per cent.

tribution of Gebrüder Sulzer to the development of the steam engine. So far as the use of superheated steam is concerned, the poppet valve is well adapted to the peculiar conditions, on account of the greater durability over the Corliss valve, as well as over the piston and the plain slide valve, there being little friction and no necessity for the use of a large quantity of high-grade lubricant. Still, it must be admitted that the use of highly superheated steam requires the use of the

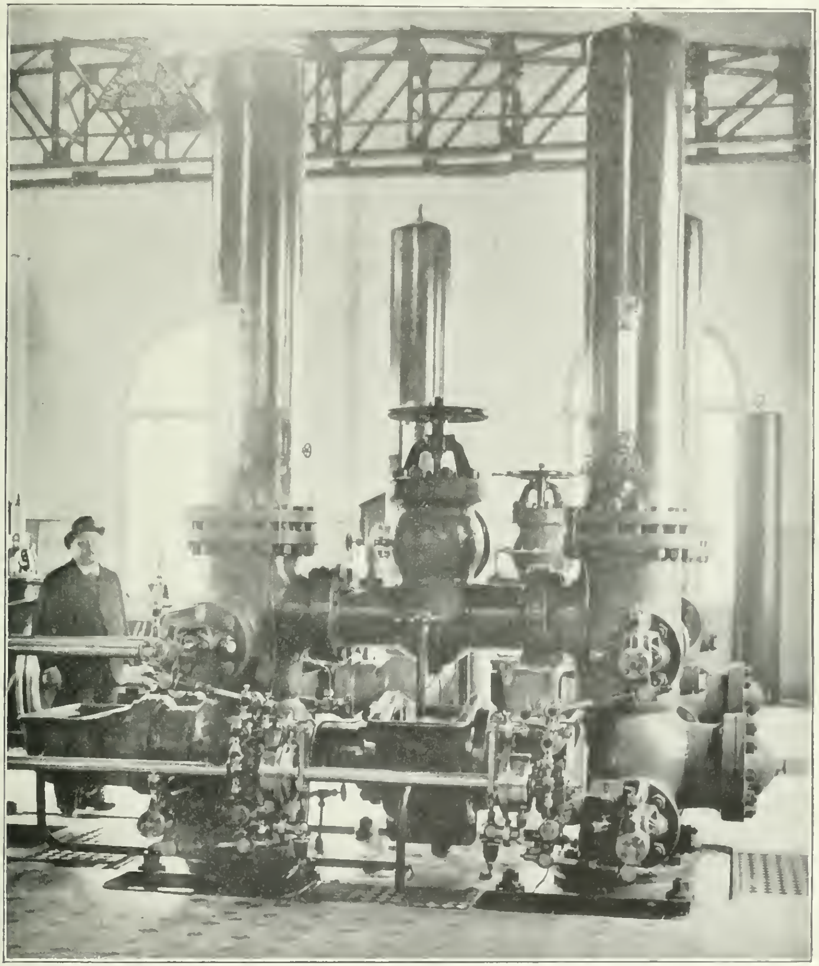


FIG. 4. PUMP END OF THE ST. GALLEN PUMPING ENGINE.

A portion of the engine shown in Fig. 3. The pump is operated by a prolongation of the low-pressure piston rod. Gebrüder Sulzer, Winterthur.

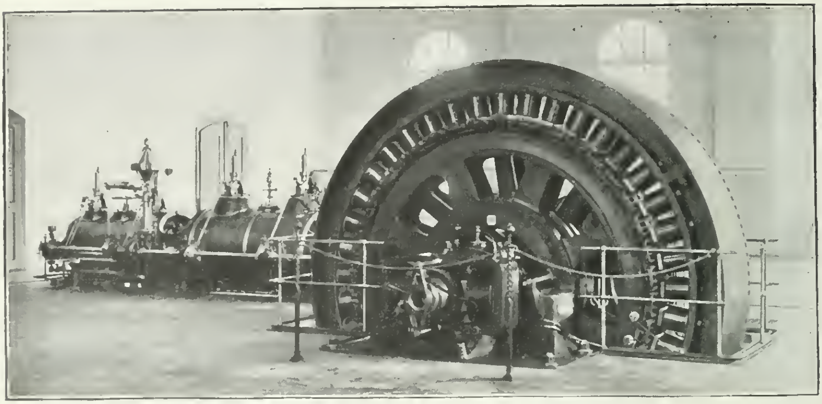


FIG. 5. TANDEM-COMPOUND HORIZONTAL ENGINE.

Direct-connected to electric generator; showing the arrangement of low-pressure cylinder nearest the crank-shaft. Gebrüder Sulzer, Winterthur.

best quality of oil in the steam cylinder, regardless of the character of the valves used.

The external valve gear of the Sulzer engines has not been materially modified since the Paris Exposition of 1878. In the case of the large vertical engines for the Berlin electric plant, which are in units of 1,500 and 3,000 h.p., the valves which are not acted upon by the governor are operated by eccentrics in connection with rocking levers. It is evident that heavy valves may be operated in a much quieter manner in this way, and brought more gradually to rest, than with the revolving cams with their more exact drop and accelerated motion.* The regulation is usually effected by the Porter governor, with its heavy pear-shaped weight and oil dash-pot, but in this case the Hartung spring governor is applied.

The external appearance of the engines is of a high degree of elegance, as will be seen by reference to the illustrations, in which the various types of engines already referred to are shown.

Fig. 1 shows a horizontal triple-expansion engine of 1,800 h.p. normal capacity, an arrangement which has been found very satisfactory for large engines. In this case there are two low-pressure cylinders, the arrangement being, on one side the high pressure cylinder and one low-pressure cylinder, and on the other the intermediate and the other low-pressure cylinder, each side being tandem, the shaft having a crank on each side of the driving wheel.

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* For a description of these engines see *Zeitschrift des Vereines deutscher Ingenieure*, 1899, page 1349. Vertical engines now represent the highest development of steam-engine construction in Europe, being used whenever the conditions are favourable—as in the case of the Berlin station, where a continuous current of moderate pressure was to be generated in an important structure in the midst of the city. The smaller engines have a speed of 100 to 107 revolutions per minute, the larger ones 85 revolutions, the former being two-cylinder compound engines, the latter triple-expansion with four cylinders, with double crank shaft, the high-pressure cylinder and one low-pressure cylinder acting upon one crank, and the intermediate and second low-pressure cylinders acting upon the other.

Especial provisions were made to permit the use of highly superheated steam, a degree of superheat of more than 300 degrees C. being employed; for further details the reader is referred to the above cited journal.

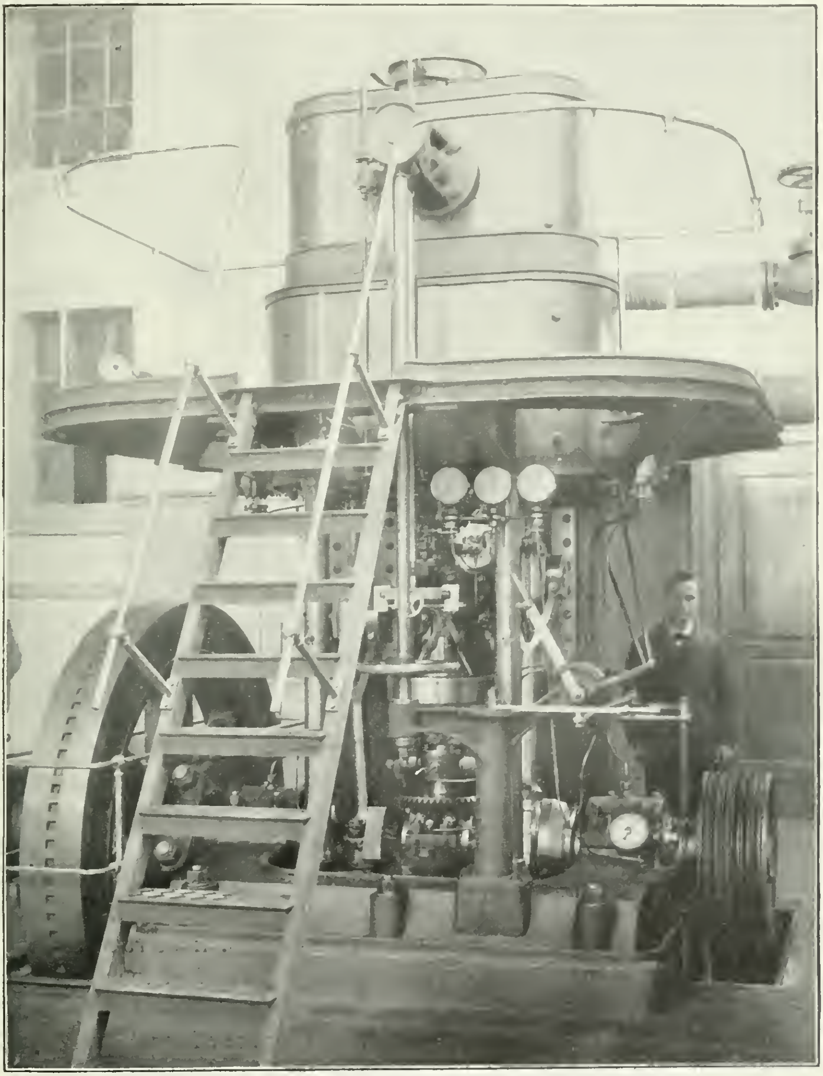

FIG. 6. HIGH-SPEED DOUBLE-CYLINDER VERTICAL ENGINE.

With rotating piston valve, driven directly from governor shaft. Gebrüder Sulzer, Winterthur.

Fig. 2 shows an engine of the horizontal tandem-compound type, being that of the 1,000-h.p. steam-dynamo in the municipal electric plant at Zürich, the most noteworthy feature being the arrangement of the large cylinder by which the steam from the receiver passes through the jacket of the low-pressure cylinder, the latter thus being maintained at a lower temperature than the high-pressure cylinder. The stuffing boxes of the two cylinders are also placed further apart than is usual in engines of this style, and the connection from the low-pressure rod to the crank shaft appears to be a more natural arrangement than the ordinary plan of placing the high-pressure cylinder nearest the shaft. This arrangement is typical of a number of Continental electric plants, having been first employed by Messrs. Sulzer for the plant at Frankfurt.

In Figures 3 and 4 are shown the steam pumps of the water works of the city of St. Gallen. In these engines the high-pressure and intermediate-pressure cylinders are placed on one side, the low-pressure cylinder and the double-acting pump being on the other side, the pump being operated by a prolongation of the low-pressure piston rod. The pump operates at 60 revolutions per minute and delivers 2,150 litres (473 British gallons) against a head of 330 metres (1,082 feet). Tests made by the author upon this engine showed an efficiency of 51 to 52 kilogrammetres (369 to 376 foot-pounds) of water raised for 1 calorie produced by the fuel (coke), corresponding to a thermal efficiency of 12 per cent., the developed energy being about 360,000 kilogrammetres (2,603,880 foot-pounds) per kilogramme (2.2 pounds) of coke of a calorific value of 7,000 calories per kilogramme, (12,627 B.T.U. per pound).*

This remarkable result, which can only be compared to a few cases in American water-works practice, is due to the superior construction of this comparatively small triple-expansion engine, and to the use of an economiser in connection with the steam boilers.

Figure 5 illustrates a tandem-compound engine, similar in construction to that shown in Fig. 2, and exhibiting especially the direct-connected alternating dynamo. In this case the armature remains stationary, the revolving field magnets forming a portion of the fly-wheel rim, connected by many arms to the hub.

In Fig. 6 is shown a remarkable vertical engine of small size, constructed by Gebrüder Sulzer, and characterised by the employment of

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* For details of this trial see the report in *Zeitschrift des Vereines deutscher Ingenieure*, 1898, page 197.

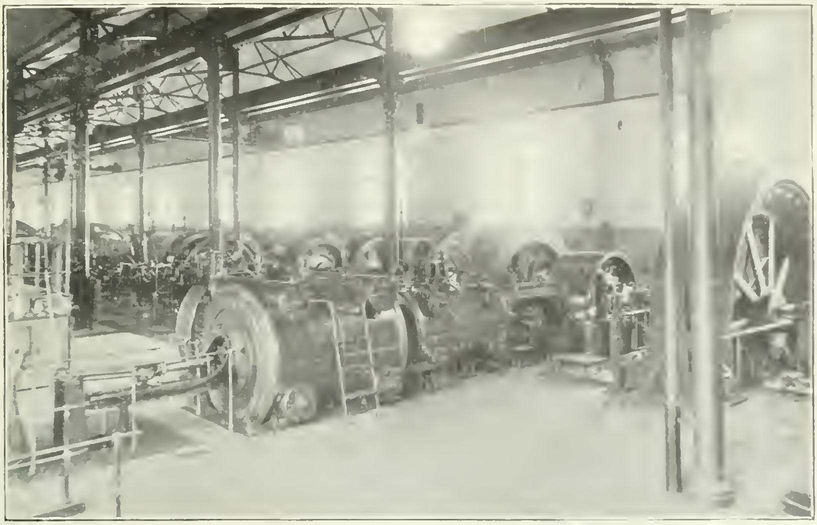

FIG. 7. HORIZONTAL TANDEM-COMPOUND ENGINE.

Frikart-Corliss valve gear with positive connection to shaft governor. Installed at Zürich Electric Station. Escher, Wyss & Co., Zürich.

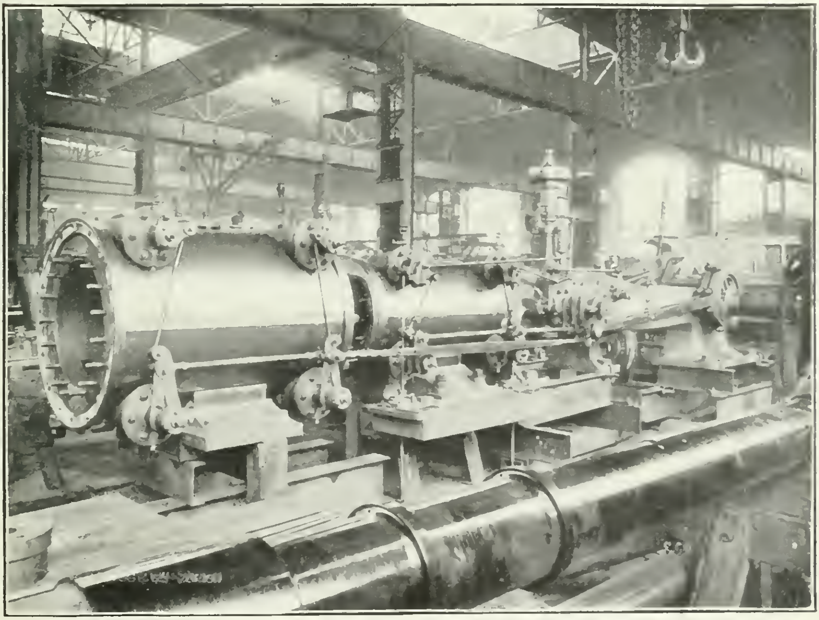

FIG. 8. TANDEM-COMPOUND ENGINE IN ERECTING SHOP.

Showing especially the simplified Frikart-Corliss valve gear, as constructed by Escher, Wyss & Co., Zürich.

rotary, hollow-piston valves. It is well known that reciprocating piston valves have been successfully operated without the use of packing rings, and Messrs. Sulzer have demonstrated that the rotary valve can also be operated for years without the employment of rings. The valves are operated by the same shaft which drives the governor, so that the only reciprocating parts of the engine are the pistons and connecting rods. This type of engine is especially adapted for high rotative speeds and is suitable to the same kind of service as engines of the Willans type, also possessing the added advantage of variable expansion. Engines of this type are made tandem-compound, and all styles possess the double-acting feature so desirable for high rotative speeds.

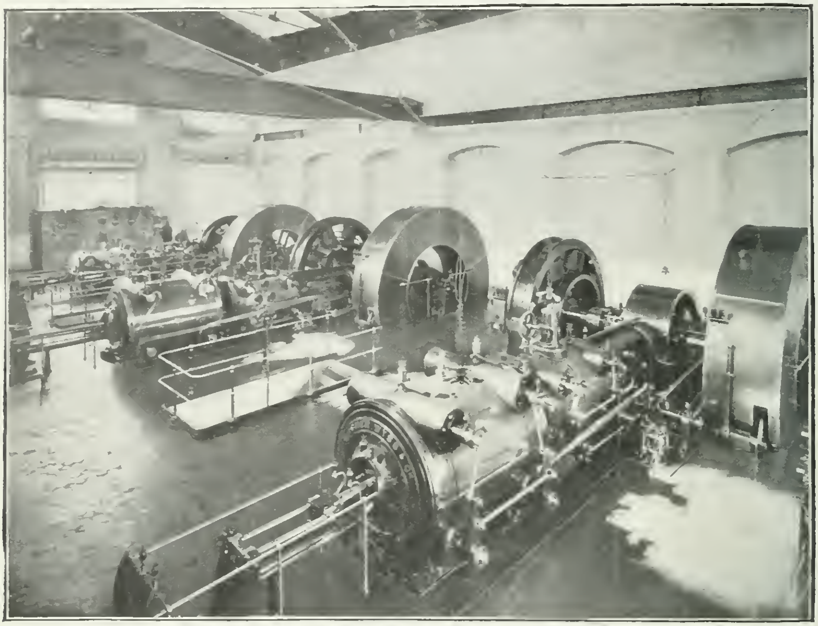

FIG. 9. TANDEM-COMPOUND CORLISS ENGINES.
Installed at the Central Electric Station, Florence, Italy. Showing the improved Frikart valve gear. Escher, Wyss & Co., Zürich.

The second notable establishment in Switzerland for the construction of steam engines is that of the firm of Escher, Wyss & Co., of Zürich. This firm was established in the early part of the present century and was originally devoted to the manufacture of turbines, in which department of engineering it has maintained a leading position. Escher, Wyss & Co. very early became interested in the construction of marine engines, and have furnished the machinery for a large number of the steamboats for many of the lakes of Europe, as well as for river steamers on the Rhine, Danube, and other streams.

More recently this firm has undertaken the building of Corliss engines, using the Frikart modification of the Corliss valve gear, or the Frikart shaft-governor, acting upon the admission valves. This form of valve gear became well known to engineers by the exhibit made by Messrs. Escher, Wyss & Co. at the Paris Exposition of 1889. Since then a number of modifications have been made by them, especially in the simplification of the gear and the elimination of many parts. The admission valves are now operated by toggle-lever connections, carried upon the spindles of the exhaust valves, the construction being clearly shown in Fig. 9. A number of other simplifications have been made in the valve gear, as will be seen in Fig. 8, which represents a tandem-compound engine in course of erection.

The arrangement of shaft governor is especially well adapted for high rotative speeds, as is seen in Fig. 7, which shows a 750-h. p. engine in the Zürich electric station operating at a normal speed of 100 revolutions per minute. The aim of this firm is to advocate somewhat higher rotative speeds than have hitherto been considered normal in Europe, without encouraging the use of dangerously high speeds.

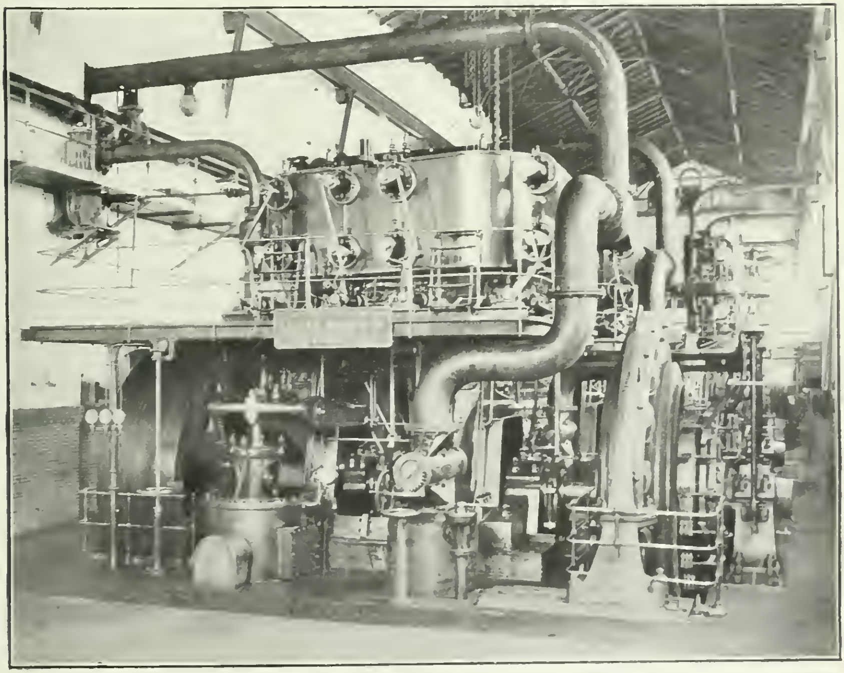

FIG. 10. DIRECT-CONNECTED VERTICAL COMPOUND ENGINES.
Corliss valve gear with positive connection to shaft governor. Escher, Wyss & Co., Zurich.

Vertical engines with shaft governors are shown in Figure 10, which represents the 800-h. p. engines in the Madrilena electric station. Escher, Wyss & Co. also build a very well-designed line of vertical engines using the Rider slide-valve gear, controlled by a very ingenious and powerful spring governor of their own design. Fig. 11 shows an installation of these engines at the St. Petersburg electric station, while Fig. 12 enables the construction of the engine to be more closely examined.

The construction of locomotives is a subject which falls somewhat outside the scope of this article. The Swiss Locomotive Works at Winterthur has for many years supplied the demands of the country alone, and in consequence of the many steep inclines of the Swiss railways, such, for example, as those of the St. Gotthard railway, has been called upon to solve many difficult problems in locomotive building.

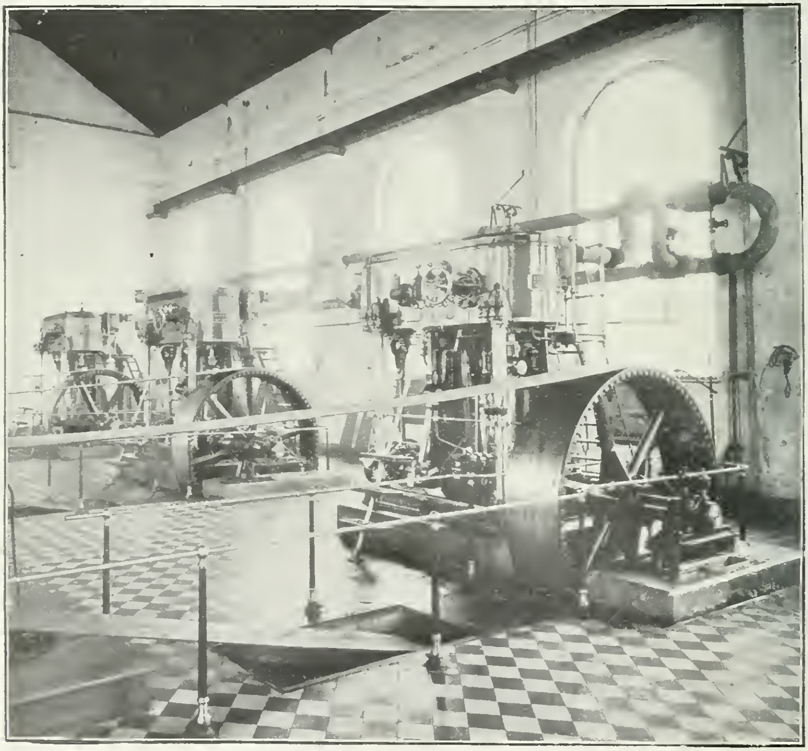

FIG. 11. VERTICAL COMPOUND ENGINES.

With Rider automatic slide-valve cut-off, as installed at the St. Petersburg Electric Station. Escher, Wyss & Co., Zürich.

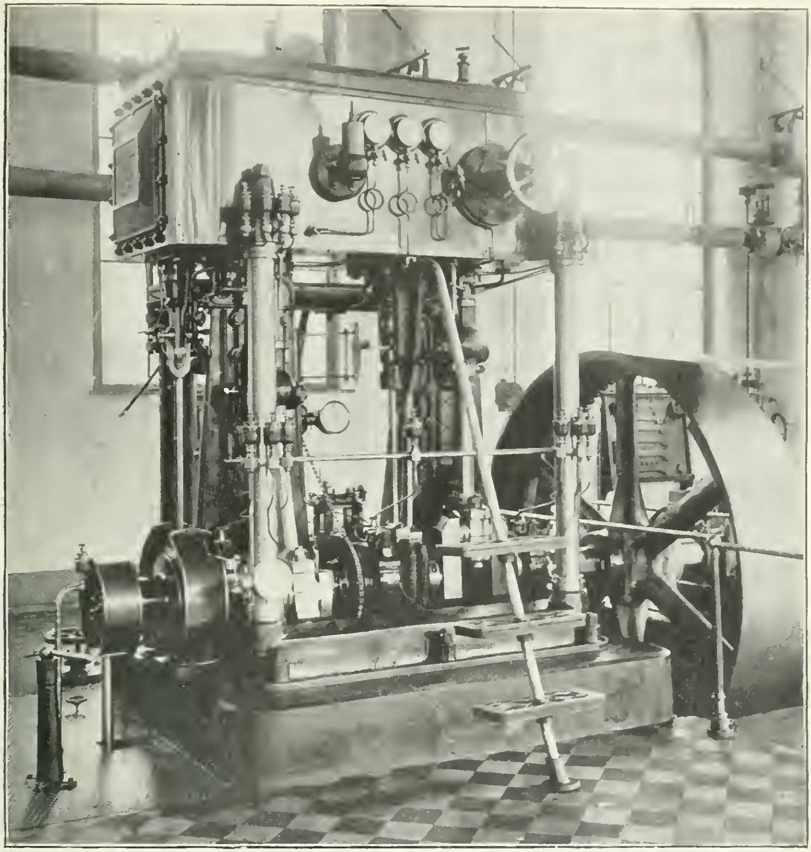

FIG. 12. ENGINE AT ST. PETERSBURG ELECTRIC STATION.

A nearer view of one of the vertical engines shown in Fig. 11, showing the Rider valve-gear and governor.

The Burckhardt Machine Works at Basle is devoted especially to the construction of air compressors, and has acquired a well-deserved reputation in connection with the construction of machinery for chemical works. The firm of E. Mertz, also at Basle, has built some excellent high-speed single-acting engines from the ingenious designs of the well known engineer, Mr. C. E. Brown, a number of these having been selected for use in the navies of foreign countries.

In this brief glance which we have taken over the steam-engine industry of Switzerland we have found little which is really new, the principal characteristic of the industry being intense activity in the development of the best points of systems already known elsewhere.

The geographical position of the country with respect to the coal and iron-producing districts of Europe, as well as its own local conditions, have compelled the closest attention to every detail, the result having been the production of a type of engine bearing most distinctly the characteristics of Swiss design as recognised everywhere. If we attempt to make a technical analysis of the features which characterise Swiss engines, we find in no part an excess of material, every portion having evidently been carefully worked out with regard to the stresses to be sustained. Bearing surfaces are proportioned with much care with regard to the effects of friction and wear, and there is everywhere evidence of artistic taste and judgment in proportioning all the parts to form a harmonious whole. This elegance of design has by no means been permitted to reach the point of weakness, since any breakdown would surely be attended by disastrous consequences, especially to the export industry.

The efficiency of the Swiss workshops stands fully as high as the standard of design. The American system of specialisation of workmen and of tools has not reached such a marked application as in America itself, although many tools brought direct from that country are in use. In one respect, however, progress has been made, namely, the use of machine tools of heavy capacity, driven to a rate of production fully as great as in America. In this respect an important change is evident.

If an opinion may be expressed as to the probabilities of the future of the Swiss engine-building industry, it must be that it depends altogether upon the favourable training and increasing intelligence of the Swiss workman, which, if rightly directed, without hindrance from labour organisations, must control the turn of the balance.

Upon this point the future development of the Swiss mechanical industry must depend, as it has in the past. If the great organisations fully grasp this fact, and are found to be in the hands of capitalists and managers who are above a mistaken parsimony, we may hope to see results which shall still be worthy of the past reputation of the country.

THE POLICY OF SECRETIVENESS IN INDUSTRIAL WORKS.

By A. E. Outerbridge, Jr.

IT is interesting to trace the gradual development of types in nature and to note their persistency when developed. This principle of persistency applies to national characteristics as well as to the organic world. Thus peoples whose boundaries adjoin and whose intercourse is frequent retain their prominent characteristics, habits of thought, and methods of work where mutual assimilation might be expected. Gradual modifications of types, however, do occur in nature owing to various causes, such as climatic variations or changes in environment. This differentiation is noticeable in offshoots of the same race and language, for instance, the English and the Americans. The tendency has been for the latter to strike out in independent lines, developing new types of thought and methods of work, while the former seem to persist in the motto *State super vias antiquas.* This racial distinction was forcibly shown in an able paper—one of a series—upon "American Competition," now appearing in the London *Engineering,* written by Mr. George Howell, F. S. S., who says: "Then it must be admitted that 'we Britishers' have our prejudices, and so strong are they very often that we stubbornly stick to old methods when newer and better ones have been discovered." In how many ways does this impress a progressive American who for the first time visits England, its colleges, its workshops, its marts of commerce and finance? On the other hand, the typical Englishman, on his first visit to the United States, opens his eyes in astonishment, if not horror, at the radical innovations in lines which he had deemed fixed.

More intimate observation of results is apt to enlighten both peoples, and each may adopt somewhat of the other's point of view, until gradually they come together, more or less, as the international yacht designers have done. The process of assimilation, or mutual modification, seems to be now taking place in many ways, among others in the extended use of automatic machine tools in England and in some methods of shop management in the United States.

English visitors to American industrial establishments have frequently expressed their astonishment at the freedom of access generally accorded to foreigners and this fact was recently commented upon by another writer, a well known English engineer, in a contribution to the symposium upon American competition already alluded to. This writer says: "The American and British manufacturers exhibit a marked difference in their willingness to impart information. The American, as a rule, will, without hesitation, take anyone through his works, show any novel methods which he may have adopted, and generally supply any information which his visitor may be anxious to acquire. English and Continental manufacturers do not thus open their works to the public and are not anxious to supply information." Apropos of this the following incident, related in the *Marine Review*, may be cited here:

"Lieut. Harold P. Norton, of the navy, who is inspector of machinery for the United States cruiser *Albany* at the Armstrong shipyards, Newcastle-on-Tyne, England, has been having a hard time trying to get some detailed information about the torpedo-boat destroyers *Turbinia* and *Viper*, which have been advertised as the most wonderful vessels ever designed in regard to speed. He was permitted to inspect the engine and the boiler-rooms of the *Turbinia*, but not to see them while the vessel was running, and he had to be satisfied with walking around the outside of the building where the turbines for the destroyers were being built. He was not even allowed to look through the doors."

It is difficult to understand the reason why the builders of the *Turbinia* and *Viper* should object to inspection of these vessels, constructed under patents issued to Mr. Parsons. If, for example, these boats had been built in the Cramps' ship yards in Philadelphia under the protection of patents, the very opposite plan would probably have been pursued. Representatives of other governments would have been invited to inspect the vessels, and perhaps to be present at the trial trips.

It is, no doubt, true that American visitors, if properly introduced—and especially if they are not engaged in similar manufacturing occupations—are sometimes escorted through the workshops in Great Britain and on the Continent; but is it not also true that secrecy is, according to the generally accepted European idea, the key to success in manufacturing? It is not true, moreover, that this system tends to preserve and perpetuate methods and machines which have elsewhere been discarded as obsolete?

A few years ago an American visitor to some English establishments was surprised at the difficulty he experienced in obtaining access to the workshops, and still more surprised and amused to find, eventually, that the carefully guarded machines and processes of manufacture would have been considered quite out of date in his own country.

Having thus briefly indicated certain radical differences in customs which have prevailed in the past in methods of management in Europe and America, it is the purpose of this paper to present evidences of a gradual but clearly perceptible change which appears to be now taking place on both continents, and the reasons therefor. In Europe it is noticed that more liberal views are developing, while in America the tendency is to draw closer the lines of policy in these matters of internal management of large industrial establishments. An illustration of this change may be found (in the foot note), in an article recently printed in the New York *Sun.* *

It is undoubtedly true that, with the keen competition in nearly all lines of manufacture, the man who invents a new machine or discovers a new and valuable process secures an immediate advantage over his competitors, which he naturally desires to hold as securely as possible for his own benefit, either by obtaining patents, or by preserving his improved methods as trade secrets. It is sometimes a puzzling question to decide which is the better means to this end.

If the novelty be a concrete form of machine, he will generally

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* "A German manufacturer who visited Pittsburg recently was surprised by the difference between the welcome he received then and about eight years ago. When he was here on the previous visit the manufacturers of Pittsburg gave an international entertainment and dined and wined their competitors from England, Germany and France, showing them the wonders of natural gas and the resources of their plants. One day the programme called for a visit to the Carnegie and other mills, and this particular German was invited to go and see how things were done in this country, he being a steel manufacturer himself. He refused the invitation on the ground that German manufacturers had nothing to learn from America, and he had come to the United States to get away from the clangor and smoke of the steel mills.

"It was different last week. Having asked permission to inspect a certain mill and see the improved machinery and methods he had heard and read about, he was surprised at finding it would be impossible to obtain the required permit, and was obliged to content his curiosity with an inspection of a smaller establishment which was not in his particular line of business. Other foreigners have succeeded in entering some of the mills, but manufacturers are becoming more and more chary in granting facilities for the inspection of their plants, and the time will soon come when experts from abroad will have to content themselves with an exterior view of Pittsburg's manufacturing establishments.

"There is a great contrast between the period when foreigners cared nothing for a visit to the mills here and the present time, when they are arriving here for that very purpose every day. The reasons all lie in the new position the United States have taken in the eyes of the nations since the close of the Spanish war. American armor plate may have had no opportunity to show its excellence in the naval battles of that contest, but the voyage of the Oregon demonstrated the value of American machinery. Military science may not have been enriched with records of great strategic manœuvres, but American vim, thoroughness and rapidity of execution, initiative and other valuable qualities were shown in the army by officers and privates. Much, probably, of the interest now shown by foreigners is due to the fact that even before the war American manufacturers had cut into the protect himself by patenting his invention, and the present tendency in such cases is to cover every possible improvement or modification that may be thought of by introducing a multitude of subsidiary clauses in the patent specifications, or else to secure a number of separate patents upon different parts of the machine. A remarkable illustration of this tendency to complexity of detail in patent applications is afforded in a patent issued a few months ago to a Philadelphia inventor, in which the claims allowed number one hundred and seventy-eight and fill eighteen columns of the fine type, closely set, of the U. S. Patent Gazette.

Some years ago two well known chemists and metallurgists discovered an ingenious process of obtaining chromium, tungsten, manganese, and other so-called "rare" metals, free from objectionable impurities and at comparatively small cost. Considerable sums of money were spent in obtaining European and American patents. I have been informed by one of these gentlemen that they have excellent reasons for believing that their processes are being extensively pirated in the preparation of certain alloys which are used in making special kinds of steel, both in the United States and in Europe; yet they have found it difficult, if not impossible, to obtain positive evidence of these illegal practices. For this reason, these experts are convinced that

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markets of their foreign competitors; but most of it, so steel makers here say, is due to the sudden opening of eyes caused by the swift conduct of the war.

"At any rate, foreign manufacturers have been coming here in droves. It is only lately that the local industry has awakened to the commercial risk of permitting promiscuous inspection of the mills. The foreign expert need not bring a camera along to catch the improvements on machinery; his trained eye takes them in as quickly, and the photograph imprinted on his mind can readily be developed on his return home.

"Every plant has machinery that may not be patented in order to prevent others from making and using it, and its secret should, therefore, be guarded jealously. Machinery in everyday use here could, of course, be obtained by the foreigner from the regular makers, but there are things besides machines which help to American success. Thus, knowledge of improved methods of assembling and utilizing machinery may be useful to the foreigner, and should be kept from him. Many labor-saving methods are used in the best establishments, and it might be best that a competitor in search of knowledge should be held in ignorance of these. One mill may have evolved a smooth, rapid, apparently involved, and yet simple system—once it is understood —of manufacturing, say, beams, from the molten metal to the finished product loaded on the railroad car. This system was, perhaps, thought out after the loss of much money in expensive experiments; it would obviously be unwise to allow some competitor to learn the secret of the network of ladles, railroad tracks from furnace to furnace, cranes and overhead travelers and other devices intended to save labor and facilitate execution. Krupp, the great German manufacturer, acquired this lesson long ago, years before Americans had learned its A B C. No outsider can penetrate to the laboratories of the great German chemical establishments, and the commercial value of this precaution to the technical sciences may be deduced from the fact that the Germans have discovered 70 per cent. of the products of coal tar and have built up a monopoly that is annually worth millions of dollars to them.

"Of course, foreigners are still coming to Pittsburg to learn, but more than one mill has shut them out, and the time will soon come when they will be obliged themselves to evolve the application of the methods by which their markets are being taken away from them."—*New York Sun.*

a serious error of judgment was committed in patenting the processes and thus advertising them to the world.

About seven years ago, a sample of a crude artificial product was submitted to me for examination and opinion as to the advisability of patenting the process of making the material, which, it was believed, was capable of valuable practical applications in the arts. The material in question was an organic compound, and in order to form a correct judgment in the matter specimens were submitted to several analytical chemists (who are specialists in organic chemistry), for analysis and report upon the materials used and the probable method of manufacture. The chemists' reports agreed fairly well as to the component elements of the compound, but the analysts differed widely in the guesses—for they were mere guesses—as to the original materials and processes employed. One chemist frankly stated that he did not believe it was possible to answer the question, because an analysis of the product did not reveal the secret of its manufacture. On the strength of these reports, no patents were taken out for the compound, but a large amount of money was expended in developing the practical application to numerous uses. A successful business has resulted.

Several years ago a certain new metallurgical process was devised and put into practical use which differed greatly from all previously known methods, and although various attempts have been made to reproduce the process they have failed, for the reason that the imitators have been unable to grasp the fundamental principles involved. Quite recently, a graduate in chemistry and metallurgy from one of the leading technical schools in the United States became an employee in the establishment where this process has been in use very successfully on a large scale for about ten years, and after having observed the process and its results he admitted that it is based upon principles diametrically the opposite of those taught in his Alma Mater to this day. This is only another evidence of the truth of the statement recently made by Dr. Coleman Sellers in an address on the occasion of the seventy-fifth anniversary of the founding of the Franklin Institute that "the shops are always in advance of the schools." There was no "Catechism of the Locomotive," said Dr. Sellers, when Mr. Baldwin first built his locomotives. There were no text books of machine tools, worthy of the name, in Dr. Sellers's youth. The text books came afterwards, and it is perhaps not an exaggeration to say that no new book upon any practical art is, or can be, quite "up to date" when issued. Even the illustrated catalogues of manufacturing establishments are confessedly never complete, so rapid are the changes and so frequently do the improvements follow each other.

An English visitor to a large machine-tool establishment in the western States gave a description of an immense machine tool which he had there seen, and stated that it is the largest of its kind in the world. Before these words appeared in print in England, a few weeks ago, three similar but much larger machines were in process of construction in an eastern establishment.

Other illustrations of this kind could be given, but these are sufficient for the present purpose; the main object of this paper being, as stated, in the first place, to show the gradual changes now taking place in the management of European and American industrial works, growing out of more frequent observations and of adoption of some of the salient features wherein radical differences have formerly existed; and, secondly, to discuss the important question of the advisability of patenting or of keeping secret new discoveries and inventions.

It is, of course, essential in a discussion of this character that the particular processes of the particular establishments alluded to should be but vaguely mentioned. The point, however, which it is desired clearly to elucidate is that it is usually unwise to patent a process, for the reason that, in order to procure a patent, it is necessary to describe the discovery accurately, so that anyone skilled in the art may reproduce it, and thus to open the door to infringement. On the other hand, assuming that a patent for an invention of a new machine has been broadly and accurately drawn, there is usually nothing to be gained by concealment, and everything to be gained by giving the widest publicity to the invention.

As the result of observation in some large establishments, and of inquiry elsewhere, I believe that it is becoming more and more the policy of manufacturers in America to keep secret improvements in processes of manufacture, and while visitors are, and probably will continue to be, cordially welcomed and even permitted to make investigations more fully than they can do at present in European establishments, these secrets are now as carefully guarded in American shops as in foreign factories.

While the foregoing is a broad statement of reasons why the patenting of a novel machine may be, and generally is, a wise procedure, and the patenting of a process inadvisable, there are exceptions to all rules. For example, in many establishments special machines have been devised and constructed which are not manufactured for sale, and are, therefore, not patented; these are carefully guarded from the public view in order to prevent competitors from copying the designs. Again, a judicious re-arrangement of the standard machines may contribute to enlarged output and decreased cost of product; this systematic arrangement of plant is not patentable, yet it may represent much thought, labor, experience, and expenditure of time and money, and may enable one manufacturer to undersell another, other things being equal. It is natural that the owner of such a model plant should adopt precautions to prevent knowledge of these improved methods from becoming public property.

There is, of course, danger that secret processes and unpatented improvements in machinery, or in methods of manufacture, may be discovered by visitors who are familiar with the nature of the business; there is also the risk that employees may be enticed away, and there are many other ways by which unscrupulous outsiders may obtain knowledge of the most carefully guarded secrets. However, one who attempts to imitate or reproduce a secret process from a partial description or examination of the product will usually discover that there is some "missing link" which he cannot find, because the intangible idea, emanating from the brain of the original discoverer, is somehow and in some degree bound up in the process, if not indeed, an integral part of it; and imitations are never equal to the genuine articles. Apropos of this an incident may be related which recently came to my knowledge. A metallurgist offered to sell to a large manufacturing establishment the secret of a process for which great claims were made by him, and he was permitted to give some practical demonstrations. It was soon found that his process was identical with one which had been successfully introduced several years before by an employee of the works.

There is no doubt that the free interchange of ideas and experiences of persons engaged in similar lines of manufacture tends to the general advancement of any art, but there is, apparently, a growing feeling that this has been somewhat overdone in America, and it is now becoming more difficult for visitors to obtain permits to inspect the large industrial establishments of the country. Within the past few years, or since the great invasion of American manufactured products, especially of iron and steel, in many foreign markets, there has been a marked increase in the number of foreign visitors, engineers, mechanics, and other experts, chiefly from Great Britain and Germany, to the large industrial establishments of the United States, and several of these visitors have given the results of their observations to the engineering world.

These articles are highly instructive to those who have not had equal opportunities of noting the great progress made in American methods of manufacture in recent years. Reading between the lines, one can perceive that these experts have made good use of all their faculties of observation and have carried home many valuable new ideas. It is far from my desire, or intention, to express the slightest regret on this account; I merely wish to record a few facts gathered from different sources which seem to indicate the probability of a coming change in policy of American manufacturers with respect to these matters of administration.

In conclusion it may be well to point out more distinctly that there are many cases where the question of patenting or keeping secret a new invention does not arise, or is easily solved. Thus, if a manufacturer of machine tools invents a new or improved machine, which he wishes to sell in quantities, and which therefore he must exhibit, he will not hesitate to patent it, for if kept secret he could find no purchasers; but if the machine is especially adapted to the improvement of his own products, or the reduction of cost, he may find it more to his pecuniary advantage not to patent the machine, but to keep it under lock and key. So also, if the chemist of the rubber trust, for instance, should evolve a new chemical process by which a low-grade crude rubber could be made to do equal duty with the purest Para article, the managers of the trust would surely endeavor to keep the process as secret as the Sphinx.

The difficult questions lie between these extremes, and it is as the case in hand approaches the one or the other that the manufacturer or inventor must balance the probable advantages and disadvantages in deciding whether or not to seek a patent.

THE WORLD'S SUPPLY OF COPPER.

By Frederick H. Hatch.

THE question of the world's copper supplies has received considerable attention ever since it has become apparent that, in spite of a constantly increasing production, there has been no accumulation of public stocks, showing that the industrial consumption of the metal has at least kept pace with production. One consequence has been a rise in prices, culminating in the metal boom of the year lately closed. The position may be gauged by an inspection of the following tables, of which No. I. shows the world's production and consumption of copper for the last ten years as calculated by the Frankfort Metallgesellschaft.* No. II. shows the position of the public stocks in Europe and America and shipments afloat for Europe on the 31st of December for the last ten years, and No. III. gives the average price obtaining for copper during the last eleven years.

TABLE I.

WORLD'S PRODUCTION AND CONSUMPTION OF COPPER FOR TEN YEARS.

Year.	Production. Tons of 2,240 lbs.	Consumption. Tons of 2,240 lbs.	Year.	Production. Tons of 2,240 lbs.	Consumption. Tons of 2,240 lbs.
1889	262,084	265,137	1894	324,195	326,624
1890	276,440	284,000	1895	345,143	349,360
1891	283,300	296,171	1896	386,340	380,000
1892	303,685	307,807	1897	410,347	414,056
1893	299,803	295,411	1898	420,950	423.510

The increased consumption of copper is, in the main, due to the expansion of the electrical industry, especially in installations for power transmission; although, at the same time, there has been a greater demand for copper in other industries, such as ship-building and marine engineering. It is in the United States that the greatest strides have been made, and that country now stands first with a copper consumption for 1898 of 117,050 imperial tons against 104,320

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* Statistical compilations of the Metallgesellschaft and the Metallurgische A. G., Frankfort on Main, 1899. The figures in these compilations, being given in metric tons, have been converted to imperial tons of 2,240 lbs.

The enormous increase in the demand for copper, which has been occasioned by the rapid expansion in the electrical industries, is probably without precedent in any line of metal production. Already the problem of finding a substitute is being actively studied, and aluminum is being put into use.

Dr. Hatch's comprehensive view of the world's resources appears at a significant time. Necessities of space confine the detailed study in this issue to the three greatest producing countries; the subject will be concluded in the April issue of THE ENGINEERING MAGAZINE.
THE EDITORS

TABLE II.

POSITION OF PUBLIC STOCKS ON DECEMBER 31, FOR TEN YEARS, IN TONS OF 2,240 LBS.[1]

Year.	Shipments Afloat for Europe.	Public Stocks in Europe.	Public Stocks in America.	Total Stocks, English, American and Afloat.
1889	5,400	93,400	29,000	127,800
1890	3,900	61,400	45,000	110,300
1891	3,400	52,600	33,900	89,900
1892	5,000	50,700	25,000	80,700
1893	4,500	42,500	26,000	73,000
1894	3,900	50,700	36,000	90,600
1895	2,900	42,700	38,800	84,400
1896	3,600	31,300	37,000	71,900
1899	4,500	27,400	21,800	53,700
1898	5,500	22,300	24,000	51,800
[2] 1897	5,300	17,517		

TABLE III.

AVERAGE PRICE OF COPPER PER TON OF 2,240 LBS., FOR TWELVE YEARS.

	London prices.[3]									New York Prices.[4]	
	Tough Cake.			Best Selected.			Chili Bars or G. M. B.s.			(Lake Copper.)	
Year.	£.	s.	d.	£.	s.	d.	£.	s.	d.	Cents per ℔.	£ per ton.
[5] 1888	77	17	0	79	11	4	81	8	1	16 2/3	77
1889	53	18	5	55	3	10	49	11	4	13 3/4	63 1/2
1890	58	19	10	61	11	10	54	7	7	15 3/4	72 3/4
1891	54	12	4	56	11	2	51	12	8	12 7/8	59 1/2
1892	48	14	0	49	18	10	45	15	7	11 1/2	53
1893	47	0	8	48	3	11	43	16	4	10 3/4	49 1/2
1894	42	16	10	43	12	8	40	9	6	9 1/2	43 3/4
1895	46	5	9	47	1	4	43	2	8	10 3/4	49 1/2
1896	49	17	8	50	13	8	47	0	6	10 7/8	50 7/8
1897	51	12	0	52	5	8	49	3	6	11 1/3	52 1/4
1898	54	14	8	55	9	8	51	17	9	12	55 3/8
[6] 1899							73	17	3		

The following is Messrs. H. R. Merton & Co.'s statement of prices for G. M. B.s, for each month of the year 1899.

Month ending,				Month ending,			
Jan. 31	£69	10s.		July 30	£76	5s.	0d.
Feb. 28	71	0		Aug. 31	76	15	0
Mar. 31	70	0		Sept. 30	75	15	0
April 30	77	0		Oct. 31	72	17	6
May 31	76	15		Nov. 30	73	15	0
June 30	76	15		Dec. 31	70	0	0

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[1] From "A Century of Copper," by Nicol Brown, London, 1899.

[2] H. R. Merton & Co.'s Circular of Statistics of Copper.

[3] Blue Book on Mines and Quarries, pt. 3, p. 182, 1899.

[4] Statistical Compilations of the Frankfort Metallgesellschaft, 1899, p. 20.

[5] Inflation of prices brought about by the French copper ring, led by M. Secretan.

[6] Average of monthly prices to December 15, 1899. (H. R. Merton & Co.)

tons for 1897. Germany also shows a great advance, owing to the vigorous growth of the electrical industry. The figures for 1898 and 1897 are 95,486 and 88,380 tons respectively. Excepting Austria, which has required an additional 1,500 tons, no other country has increased its consumption. Great Britain shows a considerable falling off, the figures for 1898 and 1897 being 96,908 and 103,605 tons respectively.

CONSUMPTION OF RAW COPPER DURING FIVE YEARS. IN METRIC TONS.

	1894.	1895.	1896.	1897.	1898.
United States	88.569	118,835	95,966	105,998	118,925
United Kingdom	100,661	83.476	104,247	105.263	98.459
Germany	56,145	63,813	79.438	89.798	97,014
France	30.689	37.738	43,224	51,869	48,536
Austria, Hungary	14.744	12.748	14.598	17,063	18,687
Russia	11,700	13,500	17,600	18.600	16,100
Italy	6.344	6,641	6,968	7.790	7,566
Belgium	5,000	5,000	5.500	6,200	5,800
Netherlands	2,400	2,400	2.400	2,400	2.400
Other European Countries.	2,100	1,900	2,100	2,200	2,100
Exports from Europe.....	1,500	1.400	1.500	1.200	1.300
Japanese Copper in Eastern Asia	12,000	7.500	12,500	12.300	13.400
Total consumption....	331,852	354,951	386,041	420,681	430,287

The world's production of copper at the beginning of this century was about 8,000 tons per annum. By the middle of the century it had increased to 20,000 tons per annum. By the year 1880 it had reached 150,000 tons, and by 1888 was more than 250,000 tons per annum. Five years ago it had passed 320.000 tons, and it is now more than 420,000 tons per annum.

An interesting compilation by Messrs. Nicol Brown and C. C. Turnbull * shows that the present century has furnished the world with over 8,000,000 tons of copper, and that the total production by the end of the century will be more than 9,000,000 tons. At the present rate of production and without allowing for any increase, the next century would see a total output of 40,000,000 tons of copper. And if production continues to increase during the next decade at the same rate as it has done during the past, it will amount to 700,000 tons per annum by 1908. Are our present known sources of copper sufficient to meet these gigantic requirements?

Thinking a review of the present supplies of copper would throw some light on the possibilities of the future, I have put together the

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* "A Century of Copper," London, 1899.

following notes on the chief mining districts from which the bulk of metal is derived. Some of these I have personally visited (Huelva in Spain, Butte and Lake Superior in the United States, Rossland in British Columbia, Sudbury in Ontario); with regard to the others I have drawn on numerous scientific and statistical publications to which references are given.

The order adopted is that of the importance of the individual contribution to the world's output, as shown in the following table.

TABLE GIVING THE PRODUCTION OF FINE COPPER FOR 1898 IN VARIOUS COUNTRIES.*

Country.	Tons of 2,240 lbs.
United States	237,173
Spain and Portugal	53,225
Japan	25,175
Chile	24,850
Germany	20,085
Australasia	18,000
Mexico	10,435
Canada	8,040
South Africa	7,060
Russia	6,000
Norway and Sweden	4,095
Italy	3,435
Peru	3,040
Bolivia	2,050
Newfoundland	2,100
Austria-Hungary	1,540
United Kingdom	640
Argentina	125
Algeria	50
Total	427,118

The total output of the world, as given in this table, differs from that already given for 1898 on page 869. This difference is due to the different methods of computation adopted in the two cases. The above table gives the amount of copper derived from the ores mined in each country, although the metal may be actually produced by smelting and refining operations in another country. The other figure was arrived at from smelters' and refiners' returns of raw copper produced from foreign and native ores and intermediate products and from official statistics of export, import, etc. A comparison of the sum of the outputs for ten years brings the two estimates into close agreement.

It will be seen from this table that by far the greatest producer is the United States, that country having furnished in the year about 55½ per cent. of the world's total supply of the metal. Spain and Portugal make a bad second with 12½ per cent. Then comes Japan with 5¾ per cent.; Chile with 5¾ per cent.; Germany with 4¾ per cent.; Australasia with 4¼ per cent.; Mexico with 2½ per cent., and the remaining 9 per cent. is made up by the other countries.

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* Compiled from H. R. Merton's "Principal Copper Supplies" for 1899 and Rothwell's "Mineral Industry" for 1898.

The rapid growth of the copper production of the United States is remarkable. That country has more than doubled its output in ten years, the mineral production for 1888 having been only 101,710 tons. The same feat has been accomplished by Australasia and Japan, the former country having produced in 1888 only 7,450 tons, and the latter 11,600 tons. During the same period Mexico has increased her output by 7,670 tons; Canada hers by 5,800 tons; Germany hers by 4,855 tons; Peru hers by 2,800 tons, and Norway and Sweden theirs by 1,800 tons, while Chile has fallen from 31,240 tons to 24,850; the United Kingdom * from 1,700 tons to 640, and Venezuela from 4,000 tons to *nil*. The production of Spain and Portugal has remained fairly constant at 52,000 to 54,000 tons.

Although copper had been discovered on the shores of Lake Superior by the Jesuit fathers as early as the end of the seventeenth century, and a little desultory mining had been done at points near the Atlantic coast during the eighteenth century, yet before 1840 the copper production of the United States was inappreciable.† In the forties, however, a few mines began to produce in the lake country (Cliff, Phœnix, Minnesota, etc.) and in the Appalachian States (Ely mine in Vermont, Bristol mine in Connecticut and the Perkiomen mine in Pennsylvania;‡ and since the year 1846 there has been a steady growth of production up to the present date, as will be seen in the table on the following page.

The copper supply of the United States at present is derived chiefly from three sources, viz.: Montana (Butte), Michigan (Lake Superior) and Arizona, these three States producing over 90 per cent. of the total. Other States contributing, but in far smaller quantities, are California (Shasta County), Colorado, Utah, and a few eastern and southern States.

The table on the following page gives the production from these sources for the last five years.

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* In 1830 Great Britain produced over one-half of the world's output of copper.

† See Dr. Houghton's geological report to the legislature of Michigan in 1841.

‡ A very interesting historical account of the copper industry of the United States is given by James Douglas in *Iron Age*, Jan 2, 1896.

TABLE GIVING THE COPPER PRODUCTION OF THE UNITED STATES FROM THE YEAR 1845 TO 1898, IN TONS OF 2,240 lbs.*

	Tons.			Tons.	
1845	100	W	1872	12,500	A
1846	150	W	1873	15,500	A
1847	300	W	1874	17,500	A
1848	500	W	1875	18,000	A
1849	700	W	1876	19,000	A
1850	650	W	1877	21,000	A
1851	900	W	1878	21,500	A
1852	1,100	W	1879	23,000	A
1853	2,000	W	1880	27,000	A
1854	2,250	A	1881	32,000	A
1855	3,000	A	1882	40,470	M
1856	4,000	A	1883	51,570	M
1857	4,800	A	1884	64,700	M
1858	5,500	A	1885	74,050	M
1859	6,300	A	1886	69,805	M
1860	7,200	A	1887	79,109	M
1861	7,500	A	1888	101,710	M
1862	9,000	A	1889	105,774	M
1863	8,500	A	1890	116,325	M
1864	8,000	A	1891	128,179	M
1865	8,500	A	1892	152,620	M
1866	8,900	A	1893	147,210	M
1867	10,000	A	1894	157,814	R
1868	11,600	A	1895	172,524	R
1869	12,500	A	1896	208,710	R
1870	12,600	A	1897	221,958	R
1871	13,000	A	1898	237,173	R

OUTPUT OF THE SEVERAL STATES, IN TONS OF 2,240 lbs.†

State.	1894.	1895.	1896.	1897.	1898.
Montana	81,739	86,950	102,213	105,874	96,866
Michigan	51,128	57,920	64,312	65,107	71,010
Arizona	19,880	21,575	32,922	36,170	49,475
California	54	101	880	6,308	9,618
Colorado	2,914	2,734	4,259	4,213	4,853
Utah	528	1,190	1,585	1,721	2,404
Eastern and Southern States	1,088	1,453	1,674	1,664	1,999
Other sources	483	601	915	901	953
Total	157,814	172,524	208,760	221,958	237,178

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* See "The Mineral Industry," 1899.

† Compiled from various sources, viz.: Whitney, "Mineral Wealth of the United States," 1854 (W); "Annual Review of the New York Metal Exchange" (A); H. R. Merton & Co.'s annual circular, "Principal Copper Supplies," (M), and "The Mineral Industry," 1800 (R).

Montana.—The copper production of this State is practically restricted to a small granite area not exceeding two square miles in extent, situated on the eastern slope of the Rocky Mountains. The mines are situated in the neighbourhood to the town of Butte, which, with the town of Anaconda, exists solely to minister to the mining and smelting industries. Butte is situated on the Northern Pacific Railway and is connected with Anaconda by the Butte, Anaconda and Pacific Railway, the distance being twenty-seven miles.

The ores worked by the Butte mines are chiefly sulphides of copper (chalcocite, bornite, and chalcopyrite), with which is associated the arsenide of copper (enargite). They occur in irregular vein deposits in the granite. The veins, which vary from a few inches up to more than a hundred feet in width, consist of the above mentioned minerals in a quartzose gangue. Near the surface they carried silver, but very little copper, and in some cases (as, for instance, the Anaconda), the mines were started for the exploitation of silver ores, the value of the copper deposits being only realised in the course of subsequent development.

The mining companies at present producing copper at Butte are the following: *

Mines.	Production during 1898. Tons of 2,240 lbs.
Anaconda	47,830
Boston and Montana	27,700
Montana Ore purchasing	5,885
Parrot	5,586
Butte Reduction Works	4,324
Colorado Smelting and Mining Co	3,420
Butte and Boston	3,120
Hecla Cons. Mining Co	58
	97,923†
Less copper in purchased ore	1,057
Total	96,866

The ores vary greatly in value according to the nature of the vein filling; but the average grade may be gauged by the output of the Anaconda group of mines, which contribute about 50 per cent. of the

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* "Mineral Industry," 1899.

† The total is somewhat in excess of that already given for the whole production of the State of Montana, but this is due to copper derived from purchased ore being included in the above returns.

total output of the district. During the year ending June 30, 1898, the company operating these mines treated at their reduction works 1,459,249 short tons * of ore, and shipped 124,417,471 lbs. of copper, 5,074,036 ozs. of silver, and 16,610 ozs. of gold, which is equivalent to a yield of 4.26 per cent. of copper, 3.48 ounces of silver, and 2 dwts. of gold per ton of 2,000 lbs.†

Michigan.—Next to Montana, Michigan produces the largest amount of copper of any of the United States. Here also the copper-bearing deposits are confined to a comparatively small area—the Keweenaw promontory on the south shore of Lake Superior. The metal occurs native, associated with sandstone conglomerate and amygdaloid trap (diabase), forming an interbedded series (Keweenawan series), of Pre-Cambrian ("Algonkian") age. The strike of the beds is N. E. and S. W. and the dip N. W., *i. e.*, towards the lake, at an angle of 40° to 55°. The average copper contents are small, but the extent and size of the ore bodies and the simplicity of ore treatment are conditions favourable to cheap and consequently profitable working.

Three classes of deposit yield copper at Lake Superior: 1. Beds of conglomerate consisting of pebbles of acid eruptive rock (rhyolite) cemented in part by native copper. 2. Sheets (flows) of basic volcanic rock (diabase) in which metallic copper is found impregnating the rock in strings, flakes, specks, and irregular masses, or lining the calcite filling of vesicular cavities. 3, Veins, intersecting the bedded rocks, and occasionally carrying large masses of native copper.

The conglomerate beds are the chief source of the lake copper, 70 per cent. of the total production being derived from the famous Calumet and Hecla and the Tamarack mines on these beds. The former company possess a large property in which the bed is being worked from the outcrop downwards. The Tamarack property is situated on a portion of the deep levels of the Calumet.

These mines are the deepest in the world, the workings extending to a vertical depth of nearly a mile from surface. Thus the Red Jacket shaft of the Calumet and Hecla has a vertical depth of 4,900 ft., while of the four shafts of the Tamarack, No. 2 is 3,649 ft. deep; No. 3, 4,450 ft., and No. 4, 4,450 ft. No. 5 will be 5,500 ft. when complete. The average stoping width is about 16 feet, while the yield of copper from the ore worked by the Tamarack during 1898 was 1.56 per cent. The Calumet and Hecla does not publish details.

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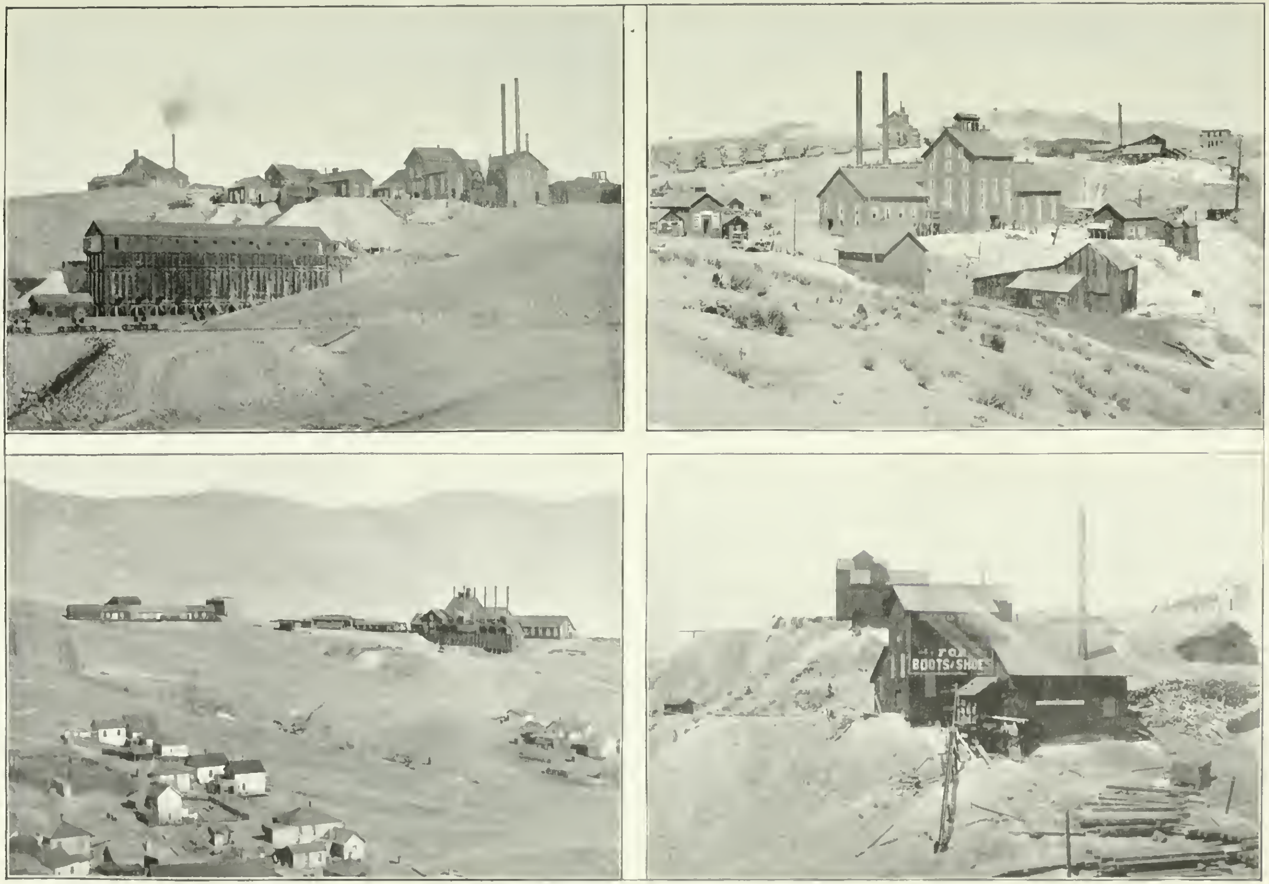
* Third annual report of the Anaconda Copper Company.

† Tons of 2,000 lbs., dry weight.

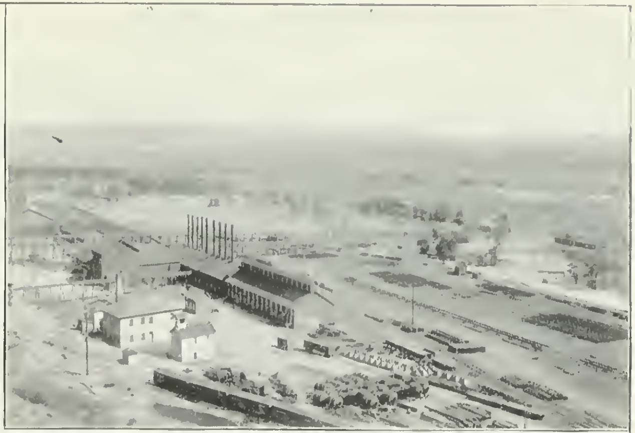


High Ore mine.
Anaconda hoisting works.

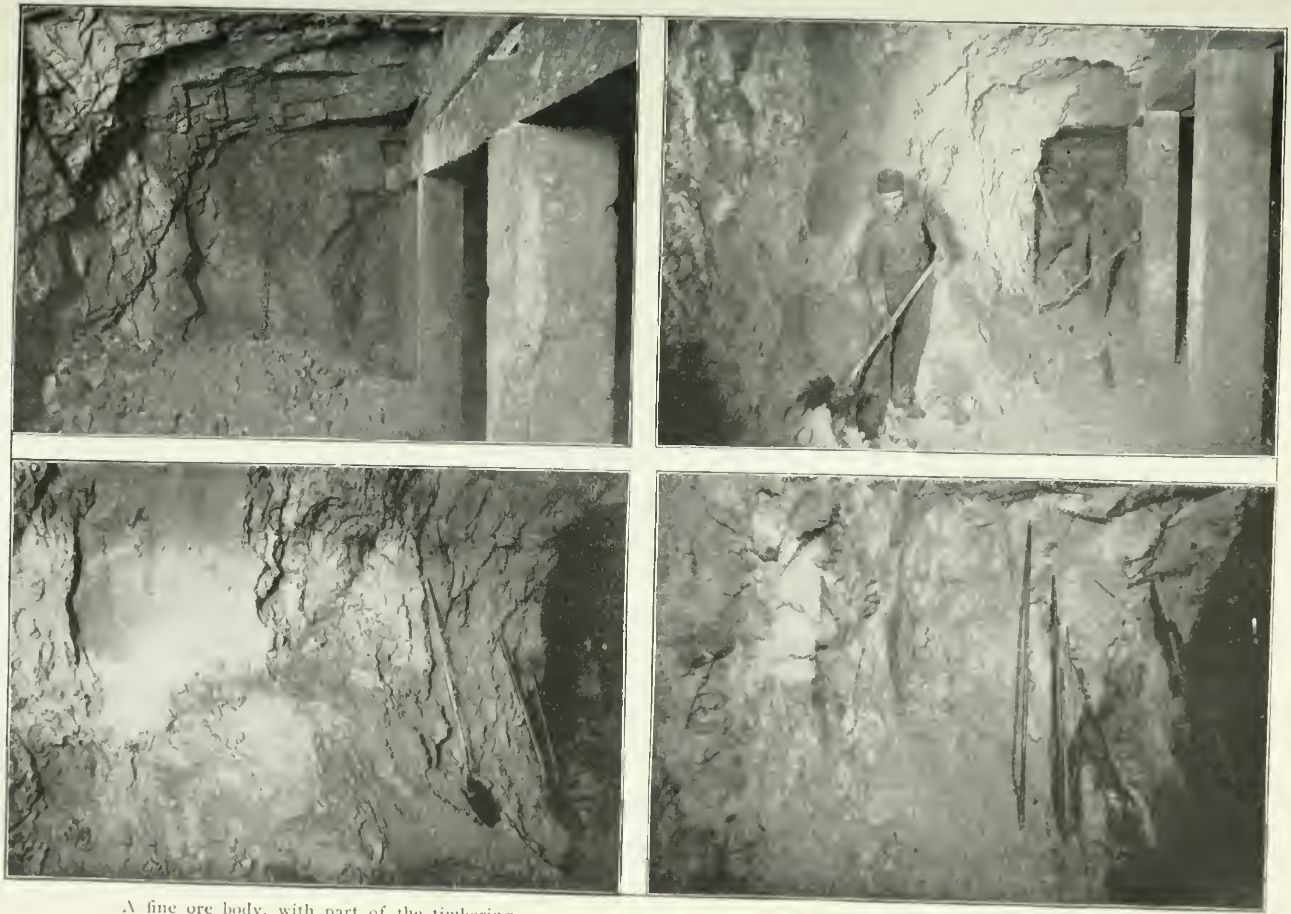
Niagara hoisting works.
Green Mountain mine.

SOME OF THE MINES OF BUTTE, MONTANA.

Upper works and Anaconda.
Butte and the Anaconda mines.



Panorama of lower works, Anaconda.
Panorama of Anaconda and the smelters.



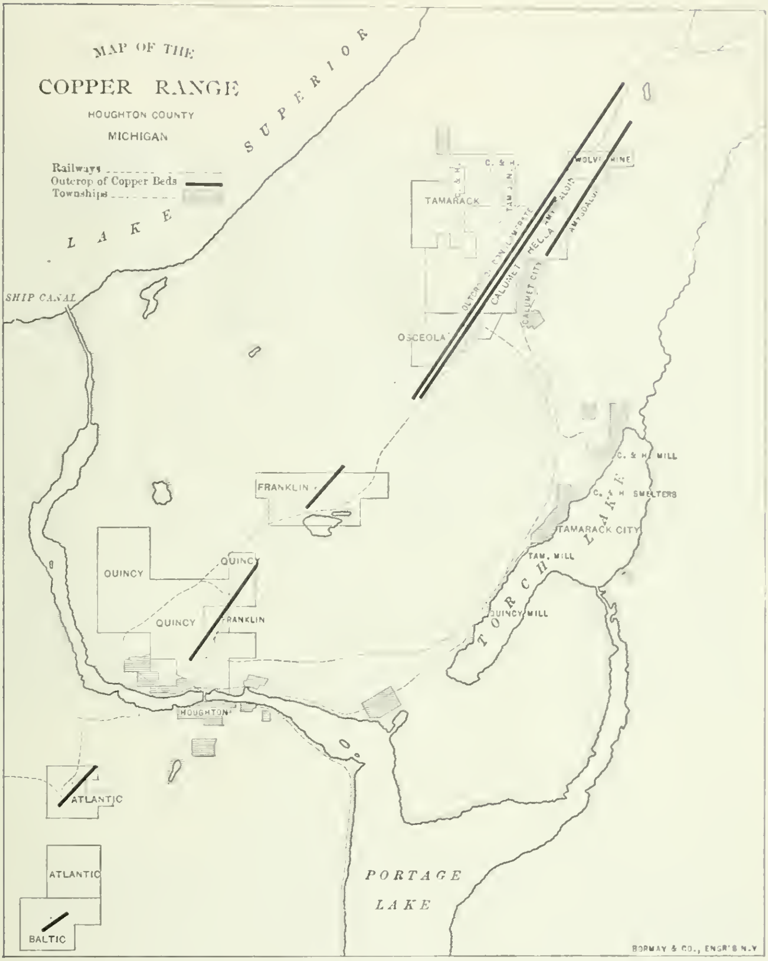
A fine ore body, with part of the timbering.
A fine ore breast, untimbered.

East sill floor breast. Miners at work.
East sill floor breast, without timbers.

UNDERGROUND WORKINGS, MT. CON, ANACONDA PROPERTIES.

From the Copper Manual. By permission of D. Houston & Co.

SMELTER OF THE BOSTON AND MONTANA CONSOLIDATED COPPER AND SILVER MINING CO., GREAT FALLS, MONTANA.



The diabase beds are worked profitably by several mines, notably by the Osceola, Atlantic, Quincy, Wolverine, and Franklin. The bed worked by the Atlantic has an average width of 15 ft. Its copper contents are low, the average yield for 1898 being only 11.8 lbs. of copper to the ton of ore, or 0.59 per cent. The yield of the Quincy is 1.56 per cent., and that of the Wolverine 1.334 per cent.

The vein deposits occur either parallel to the bedding of the formation or cut across it. They are of less commercial importance than the bedded deposits, but are remarkable for the large masses of metallic copper that have been found in them. One such mass, found in the Central mine, weighed 600 tons. The tenour of the vein mines is, however, uncertain and few of them have been worked continuously at a profit.

From the Copper Manual. By permission of D. Houston & Co.

IN THE TAMARACK MINE, MICHIGAN.

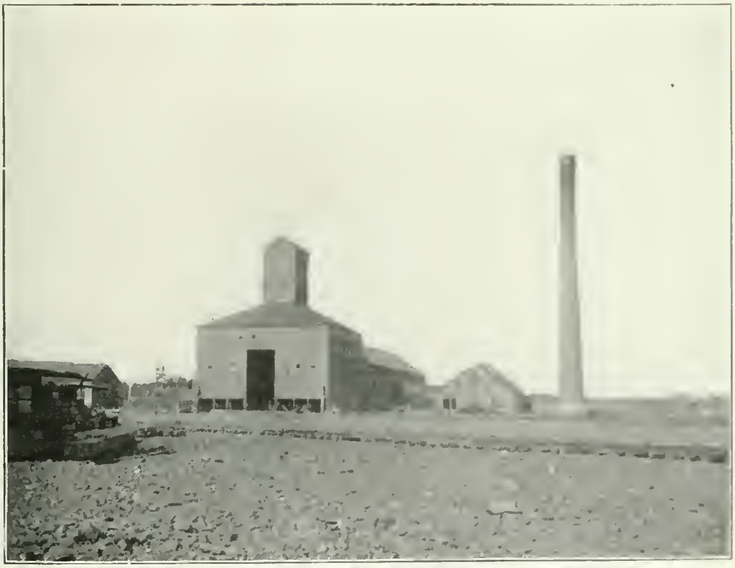
The output of the several mines worked in the district during 1898 was as follows:

Mines.	Tons of 2,240 lbs.
Calumet and Hecla	41,101
Tamarack	10,045
Quincy	7,301
Osceola Consolidated	5,268
Wolverine	2,408
Atlantic	1,959
Franklin	1,593
Central	1,300
Baltic	19
National	8
Other sources	10
	71,010

As the copper contents of the Lake Superior ores are in the form of native metal of remarkable purity, the metallurgical treatment is extremely simple. That adopted by the Calumet and Hecla Company may be taken as typical. The ore is crushed by 22 Leavitt stamps with steam cylinders, each having a duty of 250 tons per diem. After dressing with Collum jigs and Evans slime tables, the metal is run down into ingots, which are subsequently refined in the reverberatory furnace.

Lake copper is much esteemed for electrical purposes on account of its high conductivity, and consequently commands about ⅛ of a cent. per ℔. more than the current price of electrolytically-refined copper from other sources.

Arizona.*—The Arizona copper mines are famous for their large yield from oxidised and carbonated ores of copper of such purity as to permit of a single smelting to black copper by fusion with coke in water-jacket furnaces. The oxidised ores are associated with carboniferous limestone, which seems to have favoured the genesis of the secondary ores. As the mines get deeper, however, the sulphide ores begin to appear, but in most cases a rich partially oxidised product is found occupying an intermediate position between the unaltered sulphide† and the oxides and carbonates.



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RED JACKET SHAFT, CALUMET AND HECLA MINES, MICHIGAN.

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* A large amount of valuable information relating to the Arizona copper districts is given by James Douglas in the "Mineral Industry" for 1898.

† Except in the Verde mines, oxidation has extended to a depth of 400 to 500 feet.

There are four important copper producing districts—the Clifton, Bisbee, Globe, and Jerome. In the Clifton district, which is situated near the eastern boundary of the State, copper-bearing veins occur in limestone, in felsite, and in granite. The oxidised ore consists of copper oxide (cuprite) in a gangue of manganese ore (wad). In the Longfellow mine, which may be taken as a typical example of the limestone veins, the ore occurs in bunches connected by thinner branches following the planes of stratification or by cross seams in the limestone. In some of the mines, rich intermediate products are found (*e. g.* chalcocite), which in depth gives place to poorer pyritic ore (chalcopyrite). Fortunately the character of the pyritic ore permits of concentration, the sulphides being distributed through an earthy gangue which can be partially removed by wet dressing before smelting.

The mines of this district are operated by two companies—the Arizona Company, owning the Longfellow and other mines, and the Detroit Company, whose headquarters are at Morenci. The district is estimated to have produced, since the initiation of serious mining operations in 1872, nearly 90,000 tons of copper.

The Bisbee district is in the Mule Pass Mountains, Cochise County, in the southern part of the State, near the Mexican border. The ore bodies occur in limestone and consist of large masses of ferruginous clay, carrying copper in the form of carbonate down to a depth of 400 feet, after which the sulphide ores are found. At the junction of the oxidised with the pyritic ores there is often a rich secondary deposit of chalcocite.

At first the oxidised ores were smelted to black copper in a single fusion; but now matte smelting and Bessemerisation in converters has been adopted for treating the mixed oxidised and sulphide ores. The Copper Queen is the principal mining company of the district. The ore occurs in this mine in huge chambers connected by thin strings.* Its total yield since commencing operations is stated to have been 85,000 tons. The average yield of the ores, after rough sorting, is about 8 per cent. of copper, and in addition there is a small amount of gold and silver amounting in the average to about $1 per ton.

The Globe district is situated in Maricopa County, in the central portion of Arizona, north of the Gila River, and has hitherto been rather inaccessible for want of adequate railway communication. This, however, has now been remedied by the completion of the Globe,

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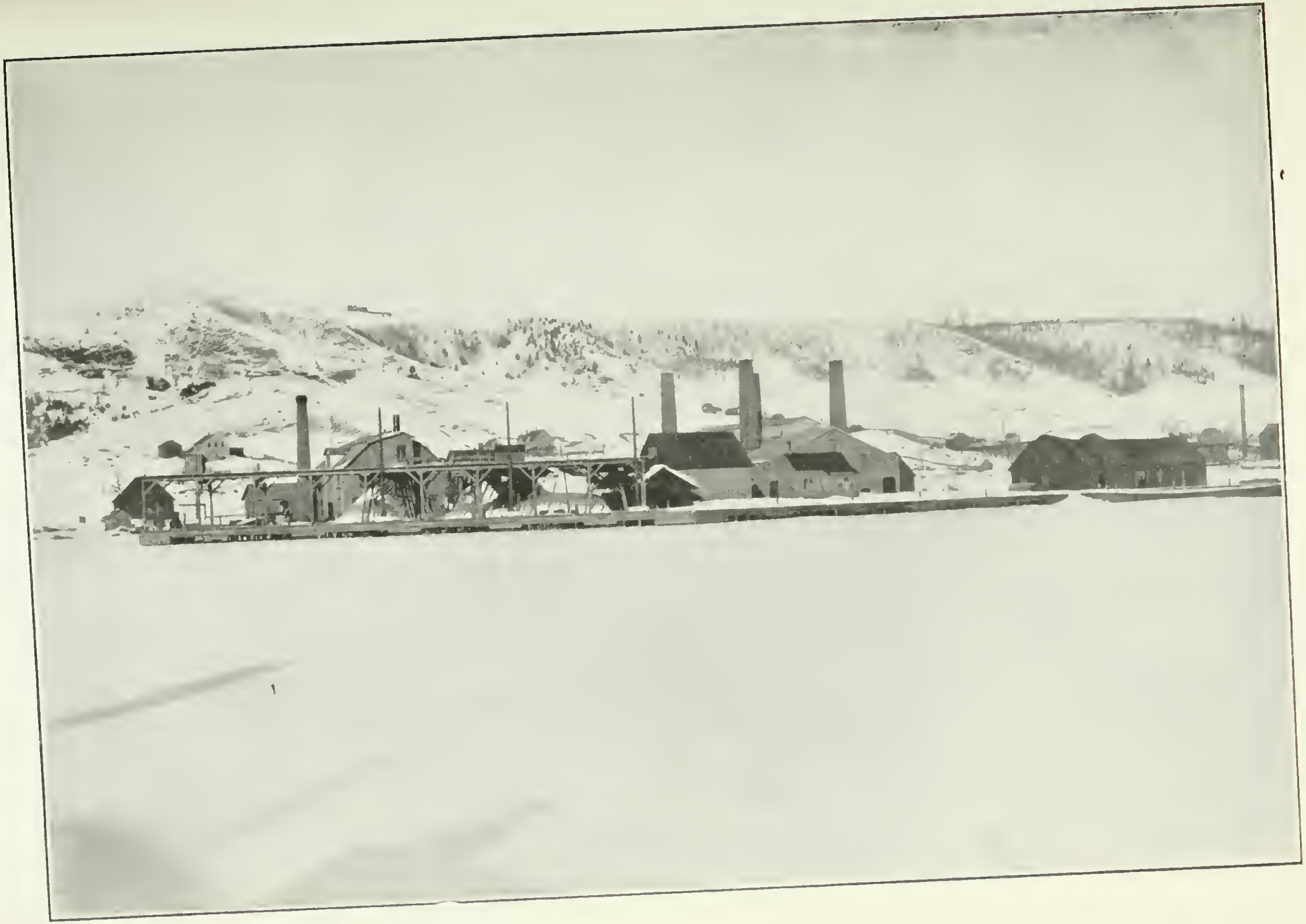
* A. F. Wendt: Trans. Amer. Inst. Min. Eng., Vol. XV., page 63.



From the Copper Manual. By permission of D. Houston & Co.

QUINCY SMELTING WORKS, HANCOCK, MICHIGAN.

Gila Valley, and Northern Railroad. The ore bodies occur in great chimney-like deposits in the limestone near and parallel to the contact of intrusive diorite. The ore consists of oxide, but contains a considerable amount of silica, necessitating the addition of limestone to the furnace charge. A pure black copper is produced by a single fusion in water-jacketted furnaces.

The total output from the district since the commencement of mining operations has exceeded 40,000 tons. At present two important companies are working, the Old Dominion and the United Globe.

MINES AND WORKS OF THE UNITED VERDE COPPER CO., JEROME, ARIZONA.

The Jerome district is situated in Yavapai County, on the eastern slope of the Black Range and near the Verde River. The ore bodies worked by these mines are lenticular masses lying in slate near the contact with the diorite. The oxidised zone does not extend to a greater depth than 150 ft., copper carbonates giving place at that depth to sulphide ore (chalcopyrite), while at the junction oxysulphides occur which have yielded much rich ore containing both gold and silver.

The present treatment of the United Verde Company is to heap-roast the sulphide ore preparatory to matte-smelting in blast furnaces, with subsequent Bessemerisation in converters.

The output of copper from Arizona for 1898 is summarised in the following table:

District.	Mine.	Tons of 2,240 lbs.
Jerome	United Verde.	18,900
Bisbee	Copper Queen	15,066
Clifton	Arizona Copper Co.	8,111
	Detroit.	5,102
Globe	United Globe.	1,271
	Old Dominion.	804
Other mines	Estimated.	220
Total		49,474

MINES AND WORKS OF THE UNITED VERDE COPPER CO., JEROME, ARIZONA.

California.*—The only important producer in this State is the Mountain Copper Company, whose property (the "Iron Mountain") is situated near Keswick in Shasta County. The Shasta ore belt extends over several miles, striking N. E. from the Iron Mountain deposit towards the Sacramento River, the town of Redding on the Southern Pacific Railway, between San Francisco and Portland, being the main base of supply. The ore bodies consist of large lenticular masses of ferruginous material impregnated with copper sulphides. The county rock in which the deposits lie is a variety of granite or porphyry. The ore has an average copper contents of about 7½ per cent., and contains small amounts of gold and silver. It carries much sulphur and iron, but is deficient in silica and consequently requires the addition of siliceous material for fluxing. The gossan ores, which extend from the surface to a depth of 125 ft., have richer gold and silver values, but practically no copper, this metal having been extracted by an atmospheric leaching process.

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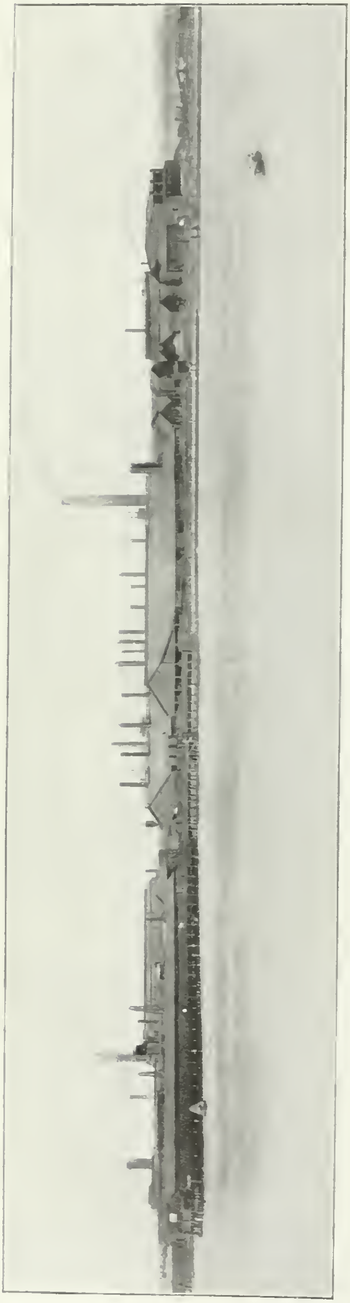
* See H. A. Keller, in the "Mineral Industry" for 1898, and M. M. O'Shaughnessy in "California Mines and Minerals," San Francisco, 1899, p. 205.

The smelting plant is situated at Keswick, with which the mine is connected by a narrow-gauge railway. The process consists of first roasting in stalls, the roasted ore being smelted in water-jacketted blast-furnaces with the addition of siliceous material and coke. The resulting matte, containing 45-50 per cent. copper, is shipped to New Jersey for further treatment. The Mountain Copper Company has now produced for three years, the amount of copper shipped in the form of matte, during these years, being as follows:

1896...	812	tons of	2,240 lbs.
1898...	6,205	"	"
1897...	9,572	"	"

Colorado and Utah.—The output of copper in these States is derived principally as a bye-product from the smelting of silver-lead and silver-copper ores in the Leadville and San Juan Districts, only one mine, the Calumet, near Salida, being worked for copper alone.



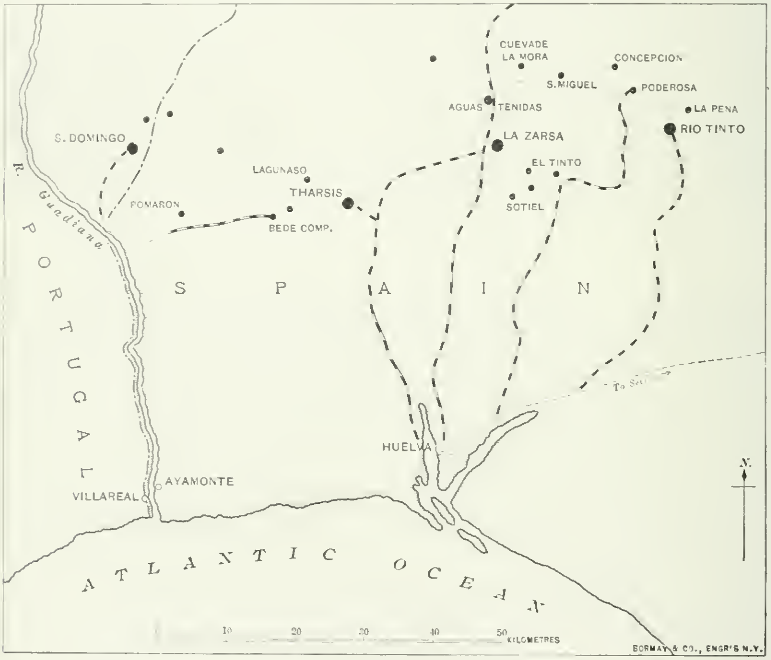
WORKS OF THE ORFORD COPPER COMPANY, CONSTABLE'S HOOK, NEW JERSEY.

CALCINING FURNACES, ORFORD COPPER COMPANY'S WORKS.

BLISTER FURNACES, ORFORD COPPER COMPANY'S WORKS.

A similar condition of things prevails in Utah, the silver smelters producing there a large proportion of the copper as a bye-product The La Sal Copper Company, however, is smelting copper ore from mines recently opened in the La Sal Mountains, near the Colorado boundary.

Eastern and Southern States.—The Appalachian States (Vermont, Virginia, Georgia, Tennessee, North Carolina, and Alabama) were once great producers, but the output is much reduced and many mines are closed, although there still exist, in the metamorphic rocks of these districts, considerable stores of low-grade copper pyrites which, with a good price for the metal, could doubtless be worked at a profit.



Spain and Portugal.—The copper mines of Spain and Portugal produce, at the present time, over 50,000 tons of metallic copper, or 12 per cent. of the world's total output. This large production comes almost entirely from the Huelva District in the south of Spain. Huelva is a port on the Atlantic coast, near the Portuguese boundary, and is the base of a mining district extending from Seville to the Portuguese boundary, one of the important mines (San Domingo), lying just within Portuguese territory. The copper mines have been famous since the earliest historical times. It is supposed that the Phœnicians visited the Spanish coast and worked copper as early as the eleventh century B. C. Certainly the Romans did an enormous amount of work in these fields, as shown by the ancient tunnelling and shafting in the mines and by the huge piles of débris accumulated at the surface. During the four centuries that the Romans worked there they are supposed to have extracted close to 1,000,000 tons of metallic copper. During the Moorish occupation no work was done in the mines, and, although mining was resumed by the Spaniards after the expulsion of the Moors, the production was of small account until the middle of the present century.*

By 1860 the production had risen to about 3,000 tons, by 1865 to about 6,000 tons, in 1870 it was roughly 13,000 tons, and in 1875 20,000 tons. More exact statisics are obtainable since 1880, the production being given by Merton & Co. as follows:

Year.	English Tons of Fine Copper.	Year.	English Tons of Fine Copper.
1880	36,313	1890	51,700
1881	39,258	1891	53,915
1882	39,560	1892	56,462
1883	44,607	1893	53,995
1884	46,415	1894	54,175
1885	47,873	1895	54,950
1886	49,653	1896	53,325
1887	53,706	1897	54,060
1888	56,450	1898	53,225
1889	54,270		

The ore-bodies consist of large lenticular masses of cupreous pyrites occurring in slate formation of Lower Silurian age and associated with intrusive igneous rocks (porphyries and diabases). Only a small proportion of the pyritic mineral is chalcopyrite, the remainder being iron pyrites. The copper percentage is small; during 1898 that of the Rio Tinto ore averaged 2.85, and the copper extracted 2.32 per cent., while other mines work ore of still lower grade. The ore, which is won in large open-cut workings, is partly treated at the mines by the cementation process (precipitation by pig or scrap iron after atmospheric oxidation and solution), and partly shipped to Europe, where the sulphur oxides obtained by roasting the ore are utilised for the manufacture of sulphuric acid, while the burnt ore is subsequently treated for the extraction of the contained copper, gold, silver, and iron. The three principal mines are under English management, viz., Rio Tinto, Tharsis (a Scotch company), and San Domingo (Mason and Barry).

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* See Gonzalo y Tarin: "Descripcion Fisica Geologica y Minera de la Provincia de Huelva," Madrid, 1886-38; and Vogt: Das Huelva Kiesfeld, Zeitsch. f. Pract. Geol., 1899, p 241.

The output of the mines has probably reached its limits, as will be seen by the following table * giving the production of fine copper in tons, 2,240 lbs., for the last five years:

Year.	Rio Tinto.	Tharsis.	San Domingo.	Sevilla.	Other Mines.	Total.
1894	33,000	11,000	†4,200	1,170	4,805	54,175
1895	33,500	12,000	†4,100	1,050	4,300	54,950
1896	33,000	12,000	†3,900	1,025	3,400	53,325
1897	33,900	†12,000	†4,300	800	3,120	53,225
1898	33,705	†12,000	3,600	810	3,050	54,060

Japan.—This country has long been an important producer of copper. The metal was discovered as early as A. D. 698, but smelting on a large scale was not carried on until the beginning of the sixteenth century. Between the years 1609 and 1858 the annual production is estimated to have averaged 2,800 tons per annum, of which a large proportion was exported by the Dutch and Chinese merchants. ‡ At the present time about half the total production goes to domestic consumers. The output for five years is as follows: §

Year.	Tons of Fine Copper. (2,240 lbs.)
1894	20,050
1895	18,430
1896	21,000
1897	23,000
1898	25,175

The ore-bodies consist of veins of low-grade sulphide ores (chiefly chalcopyrite, but with some chalcocite and bornite). Oxidised and carbonate ores appear to be rare. The most important mines are situated in the north of Nippon, in the Province of Rickuchin. Among the largest producers may be mentioned the mines of Ashio, in the district (ken) of Totsigi, Ani and Osarisawa, in the district of Akita, Besshi in the district of Yechine, and the Ozaka mine in the district of Sakai. There are also important mines on the Island of Shikoku, for instance the Kumayama, in the district of Jehime.‖

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* Merton & Co., Principal Copper Supplies.

† Estimated.

‡ Dr. Geerts estimated that during these years 280,000 tons (of 2,000 lbs.) were exported by the Dutch and 250,000 tons by the Chinese merchants. Trans. Asiatic Soc.

§ H. R. Merton & Co., Copper Supplies.

‖ See Munroe, Tran. Amer. Inst. of Min. Eng., 1877. p. 235.

THE WORLD'S SHIP-BUILDING.

By Benjamin Taylor.

IN all the history of industry we shall search in vain for any year to equal that which has recently closed. For five years there has been a gradual ascent from the vale of depression in which commerce and industry had so long languished. That ascent became accelerated in 1898, and in 1899 we reached a high-level in both hemispheres. Not a little of that industrial activity is ascribable to the enormous demand for sea-carriers and sea-fighters. Every country in the world has been bent on increasing the merchant navy, just as every maritime power in the world has been adding to its naval armaments. Shipping is not only one of the oldest occupations of man, but it affords more employment than any other industry in the world. Three-fourths of the earth's population are dependent on ship-building, shipping, and sea commerce. But ship-building is a very different thing from what it was in the good old days of the New England ship-builder, of whom Longfellow has sung. "Ship" is a wide term. It includes Noah's ark, the Oregon, and the submarine Holland. But as the world keeps spinning down the ringing grooves of change, it is a comfort to know that a ship need never cease to be a thing of beauty. We lament the lovely curves and the swelling sails of the Baltimore clippers, but were these craft more beautiful in their way than are in theirs those graceful and stately monsters of the Oceanic and Campania type, which now churn the Atlantic? Whether or not, we have got to put up with the monsters, whose coming has both created and been created by an industrial and mechanical revolution.

About 2,500,000 tons were added to the world's ocean shipping in 1899—a total of some 200,000 tons over even such a prolific year as 1898, and far beyond precedent. The proportion of the United Kingdom, according to the trade returns (but not according to Lloyd's Register, to which we shall presently refer) was 1,731,543 tons built in private yards and in government dockyards. We will first show

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The interest of a review of ship-building—the greatest of all engineering industries—needs no demonstration. It is, however, especially instructive to compare the magnificent figures of England's output, under a free-ship policy, with the barren returns from the United States, where blind efforts are still being put forth to bolster up an artificial "protective" system under which American shipping has nearly been driven from the sea. It will be of interest to review Mr. McKechnie's articles on Ship-Building as a Productive Industry in Great Britain, Dec., '97—Mar., '98; Mr. Dunell's on The Prospective Expansion in American Ship-Building, Apr., '99, and Rudolph Haack's on The Development of German Ship-Building, Aug.-Nov., '99.—THE EDITORS.

what the United Kingdom has done, according to the reports of the builders themselves.

OUTPUT OF UNITED KINGDOM.

	1899. Tons.	1898. Tons.
Scotland.		
Clyde	491.074	466,832
Firth	15.642	26.624
Tay	17,908	14.292
Dee	11.973	7.449
England.		
Tyne	307.951	307,324
Wear	268.508	262,969
Tees	144.101	146,624
Hartlepool	139,600	119,040
Humber	32.287	33,880
Mersey	13,584	4,026
Thames	21.205	38,294
Barrow and Union Ports	66,887	51,079
Government Dockyards	69,100	73.090
Ireland.		
Belfast, etc	131,723	121,330
Total U. K	1.731.543	1,672.853

And the following is an estimate of the world's output of tonnage:

	1899. Tons.	1898. Tons.
United States	267,600	237,600
Germany	260,000	171,800
Canada	5,000	18,000
Holland and Belgium	59,000	49,200
Norway and Sweden	28,000	26,360
France	62,000	26.770
Italy	46,000	22,900
Denmark	23,000	13,250
Russia	40,000	20,000
Austria	10,000	11,650
Spain and Portugal	7,000	120
Japan	12,000	11,420
China	5,000	——
Singapore, etc	3,600	——
Other Countries	10,000	10,000
	838,200	619,070
United Kingdom	1,731,543	1,672,853
Total World	2,569,743	2,291,923

Lloyd's returns differ from these compiled from the figures supplied by the builders, and for this reason, that builders include craft of all sorts and sizes, whereas Lloyd's exclude everything under 100 tons. According to Lloyd's figures, there were 714 merchant steamers of 1,414,774 tons and 12 sailers of 2,017 tons, in all 726 vessels of 1,416,791 tons, and 35 warships of 168,590 tons displacement—a grand total of 761 vessels of 1,585,381 tons—built in the United Kingdom last year. These totals exceed those of the "record" year 1889 by 207,000 tons in merchant vessels, and by 127,000 tons in warships. It was practically all steam tonnage last year, whereas in 1889 10 per cent. of the output was in sailing vessels, and in 1890-93 the proportion of sailers was 19 per cent. Stated in percentages, the proportion of sailers to steamers built in 1899 was just about 0.13 per cent. Of the total British output, upwards of 80 per cent., or about 1,150,000 tons, were added to the British register. Per contra, that register was reduced by 273,000 tons in wrecks and by 640,000 tons of old vessels sold to the colonies and foreign countries. This last item, again, has a set-off in the shape of purchases from foreign and colonial owners to the extent of 77,000 tons. It follows from all this that the net increase in British effective tonnage on the seas was about 313,000 tons, which exceeds the addition of 1897 by 265,000 tons, but is less than the addition of 1898 by 14,000 tons.

Rather less than 20 per cent. of the British output was for foreign and British colonial owners, as compared with 22 per cent. in 1898, 25 per cent. in 1897, and 30 per cent. in 1896. These figures show a decreasing demand on British builders as a consequence of the development of ship-building in other countries, but it is well to remember that the totals of recent years were considerably swelled by the requirements (now satisfied for the present) of Japan for warships and big mail steamers. Notwithstanding the development of her own ship-building, Germany is still the largest buyer of British vessels, having taken in 1899, 19 steamers of 68,057 tons, this comparing with 9 steamers and 37,045 tons in 1898, and with 8 steamers of 30,507 tons in 1897. The next largest customer for British ships was Austria, 36,837 tons; followed by Norway, 28,419 tons; Spain, 25,586 tons; Denmark, 23,597 tons; Holland, 22,312 tons; Russia, 14,984 tons; Sweden, 9,346 tons, and Belgium, 8,279 tons. The British colonies took from the mother country 14 vessels of 17,904 tons, as against 12 of 19,022 tons in 1898 and 17 of 23,009 tons in 1897. These are merchant craft, in addition to which British builders launched for other countries 17 war vessels of a displacement of 47,450 tons, including a ship of 3,770 tons for the United States. At the end of the year, British builders had on hand for foreigners 30 warships of a total of 84,305 tons displacement in various stages of construction. For the

British Government, they had on hand 36 warships of 199,530 tons displacement, in addition to 15 ships of 139,920 tons in various stages of construction at the Royal Dockyards.

Lloyd's estimates for the United States do not correspond with the figures issued by the Bureau of Navigation which we have adopted in the foregoing estimate. They summarise thus:

UNITED STATES TOTAL OUTPUT

	1899.		1898.	
	No.	Tonnage.	No.	**Tonnage.**
Steamers	421	160,132	550	169,602
Sailers	533	107,510	405	67,998
Total	954	267,642	955	237,600

UNITED STATES LAKE AND RIVER OUTPUT.

Lakes	70	72,094	66	75,067
Rivers	112	11,942	111	14,605
Total Inland	189	84.036	177	89.672

Deducting the tonnage constructed for inland navigation, we find the United States last year turning out for ocean and coasting navigation 765 vessels of 183,606 tons, as compared with 778 vessels and 147,928 tons in 1898.

OUTPUT OF VESSELS OF MORE THAN 100 TONS.

COUNTRY.	Built in 1895. Tons.	Built in 1896. Tons.	Built in 1897. Tons.	Built in 1898. Tons.	Built in 1899. Tons.
Austro-Hungary	18.471	11,796	8,851	11.632	11.548
Belgium	1,270	1,675	1,899	833	423
British Colonies	10,381	11,124	12,431	25.021	8.464
Denmark	10,982	14,014	13,539	12,703	30,083
France	70,922	105.500	64,526	101,718	155,674
Germany	94,126	117,345	191,042	168,405	252,464
Holland	9,447	21,015	25,871	30,294	39,144
Italy	18.943	28,709	48,816	29,366	66,952
Japan	5.096	7,849	11,390	11,424	6,775
Norway	12 873	12,059	17,248	22,670	27,853
Portugal	......		......	442	1,917
Russia	5,669	28,196	5.913	31,938	34,305
Spain	9.949	7,830	9,765	.....	......
Sweden	2,767	8,375	6,984	12.985	11,707
Turkey	......	......	......	760	400
United States	96,911	200,477	94,598	240,900	233,408
	367,807	575,964	512,873	701,691	881,117
Deduct Warships	100,614	167,833	133.435	175,318	176,170
Total Merchant Tonnage	267,193	408,131	379.438	525,773	704,947

The disagreement between Lloyd's figures and those of the Bureau of Navigation with regard to the output of the United States is unfortunate, because it rather vitiates the foregoing comparative statement of the world's output outside of the United Kingdom. It extends over five years, and, allowing for what we have just said, it affords a very good idea of how ship-building has progressed and is progressing beyond the British Isles.

And the following, compiled from Lloyd's returns, shows the tonnage of vessels of more than 100 tons in course of construction in each of the countries on the 31st of December in the last five years:

COUNTRY.	1895. Tons Gross	1896. Tons Gross.	1897. Tons Gross	1898. Tons Gross.	1899. Tons Gross.
Austro-Hungary	.....	4,500	700	8,186	14,600
Belgium	..	2,850	......	4,000	4,300
China	150	..	275	300	10,825
Denmark	5,587	15,445	3,403	14,738	12,114
France	37,458	65,898	50,978	73,934	102,086
Germany	80,324	104,739	84,071	168,134	200,180
Holland	13,400	16,015	20,956	22,696	31,555
Italy	6,820	15,120	22,310	61,500	107,950
Japan	417	10,930	16,785	10,000	4,432
Norway	5,066	9,026	14,626	22,160	21,959
Quebec	.....	......	140	......	530
Singapore	715	949	......	230	......
Spain	949	..	......	......	2,000
Sweden	1,816	2,850	4,100	4,425	3,040
United States	24,275	19,627	15,552	69,645	104,384
	176,977	271,849	236,896	451,968	619,955

Our own figures show the development to be even greater than Lloyd's reveal.

Amongst seven largest builders in the world last year were two German firms. Thus:

	Tons.
1. Harland & Wolf, Belfast	82,634
2. Wm. Gray & Co., West Hartlepool	77,500
3. The Vulcan Co., Stettin	68,712
4. The Furness Co., West Hartlepool	62,100
5. Blohm & Voss, Hamburg	59,300
6. The Armstrong-Whitworth Co., Newcastle-on-Tyne	57,550
7. Russell & Co., Port Glasgow	52,500

As the world's output in 1899 included 345,000 tons of warships, we may take it that the addition to the world's supply of mercantile tonnage was about 2,250,000 tons, from which have to be deducted the losses by wreck and natural decay.

It is practically impossible to grasp the amount of power involved in the production and employment of this tonnage. The numerals to which we habitually attach the initials i.h.p. afford but a very imperfect conception of even the motive portion of it. And yet it is practically all we can reduce to terms of type. Ship-building and marine engineering are nowadays practically convertible terms, at all events, in Great Britain, where the sailer has "passed." But every ship-builder is not a marine engineer, nor is every builder of marine engines a builder of ships. In connection with ships, the following was the engine power production of the United Kingdom:

			I. H. P.
Clyde-built	marine	engines	478,503
Firth	"	"	15,556
Tay	"	"	22,030
Dee	"	"	12,310
Tyne	"	"	276,379
Wear	"	"	139,119
Tees	"	"	85,200
Hartlepool	"	"	45,000
Humber	"	"	45,000
Mersey	"	"	35,000
Barrow	"	"	34,500
Thames	"	"	90,000
Other ports	"	"	25,000
Belfast	"	"	96,280
Total			1,399,877

American readers may perhaps not be prepared to find so large a proportion—more than one-third—of marine-engine power of the United Kingdom produced on the Clyde. Yet the Clyde did not show the largest individual total last year. First place among British marine-engine builders was occupied by Messrs. A. Laing & Co., Wallsend-on-Tyne, with 67,600 i.h.p.; the second by Messrs. Harland & Wolff, Belfast, with 66,150 i.h.p., and third place by Messrs. John Brown & Co., Limited (late Clydebank Shipbuilding & Engineering Co.) Glasgow. The world's record, however—88,300 i.h.p.—is held by the Vulcan Company, Stettin, who, as we have seen, were also third on the list of ship-builders.

Such production as we have indicated in the capacity and motive power of vessels indicates that in every producing centre the resources of ship-yards and engine-shops were taxed to their utmost capacity. When it is recalled that in the early part of 1898 the operations of British builders were to a considerable extent restricted by the engineers' strike, which was not really terminated until February of that year, it does not seem such a great thing that the addition to the

British output in 1899 was only some 60,000 tons, while the increase of the rest of the world was about 200,000 tons; we cannot put it at more, as the returns from some of the countries are illustrative rather than authoritative. But the explanation is that in Great Britain production was seriously retarded—especially in the latter portion of the year—by the very tardy delivery of building material, owing to the inability of makers to get prompt and sufficient supplies of crude iron and fuel. The same difficulty is still being felt, and a good deal of the tonnage that has been put into the water this year (1900) would, under normal conditions, have come under the records of output in 1899. At the beginning of 1900 there were "under construction" in the shipyards of the United Kingdom 1,306,751 tons of merchant vessels and 423,755 tons of warships, some of which last, however, being off the stocks, have been included in the launches of 1899. As regards merchant vessels, the tonnage on hand at the beginning of 1900 was about 95,000 tons less than at the beginning of 1899, but the total of this year may, nevertheless, exceed that of last.

In the case of America and Germany, the development also is in the production of steam tonnage, but in France it is different. Practically three-fourths of the tonnage given on our list above as turned out in France last year was sailing tonnage, for France occupies the unique position of being the only country in the world which is adding to its fleet of large-sized sailing vessels. No fewer than 24 sailers of 2,000 tons each and upwards were launched from French yards last year. This is because, under the bounty system, this is the kind of vessel that can extract the largest amount of bounty from the State. The Ville de Mulhouse and the Ville de Havre, of 3,200 tons each, built at Havre, are the largest sailing vessels afloat. In French yards there were also under construction last year some 14 warships, which are not included among our figures of tonnage launched. These include one vessel of 9,400 tons for Japan, one of 3,160 tons for Brazil, and one of 350 tons for Russia, the rest being for the French navy.

It may be noted here that, besides these warships building in France and the 35 named above as produced in British yards for foreign navies, the only other warship-building for other countries reported by Lloyd's, is, in Germany, one of 9,850 tons for Japan, three of 1,050 tons for Russia, and two of 640 tons for Italy; and, in America, one of 6,500 tons for Russia.

In examining the compositions of the addition to the world's merchant fleet, three outstanding features are revealed, viz: (1), the increasing use of steel; (2), the increasing size of cargo as well as passenger carriers; and (3), the increasing power and speed, both of passenger boats and of big cargo liners.

In the matter of materials, if we exclude the United States and Canada, there were probably not 10,000 tons of wood or "composite" vessels built in all the maritime countries. The proportion of such is not more than 0.1 per cent of the new tonnage. On the other hand, 98.8 per cent. of the new tonnage last year was of steel and 1.1 per cent. of iron. The new iron vessels were all of small tonnage, and consisted of steam trawlers and such like craft. We are, in fact, in the steel age of ship-building. Never before in the world's history was so much steel required as in 1899. Yet the probability is that the world's needs this year will be even greater. And in connection with this feature of the year has been the inevitable rise in the cost of construction, due to the great rise in the price of material in such general pressing and increasing demand. As to this, we shall have a word to say later on.

The temptation to review strictly naval work must be resisted, though some of the new vessels, and in England notably the Cressy, present many interesting features of improvement in armour and armament.

Except in the case of the Viper, there was last year no great novelty in mechanical appliances introduced, and the Viper herself is still a dark horse—but the more general adoption of the twin-screw is noticeable. And another feature was the number of cases in which merchant steamers adopted the water-tube boiler. The adoption is not, of course, by any means general—far from it—but it is a fact that ship owners seem gradually coming over to the views of the Admiralty with regard to this form of boiler. The outstanding mechanical feature of the year has been in the increase of the power per ton of merchant-steamers.

While the twin screw has become more general, it should be noted that in two new steamers of the Castle (Cape) line—Kinfauns Castle and Kildonan Castle, built on the Clyde—the single screw was reverted to. On the other hand, the German battleship Kaiser Karl der Grosse, of 11,000 tons, built by Messrs. Blohm & Voss, Hamburg, is fitted with three screws.

In illustration of the foreign work of the year, this Hamburg firm built a twin-screw of 12,400 tons, two twin-screws of 10,300 tons each, one of 10,500 tons, and one single-screw of 4,850 tons. The Vulcan yard at Stettin turned out a German warship, Kaiserin Maria Theresa, of 8,285 tons, the Patricia, of 13,290 tons, and the König Albert, of 10,-

040 tons. The Kaiser Wilhelm der Grosse battleship (not to be confused with the North German Lloyd liner of the same name), is of 11,000 tons, and was built by the Germania Company, at Kiel. The largest items of production of Holland, Italy and Russia were war vessels, none, so far as reported, exhibiting any novelty in type of structure.

Touching the structure of big ocean carriers, in order to secure size and speed, the use of nickel steel will become more common. Sir William White, of the British Admiralty, has calculated that in an Atlantic liner of 20 knots a weight of about 1,000 tons could be saved by using nickel steel instead of mild steel. The greater becomes the size of ships, the more important must this saving be. It is only within the last forty years that we have seen the evolution of steamers making over 11 knots, and at a much more recent period the fastest Cunarder did not exceed that speed. It was not the question of model, but of machinery and material—perhaps more of material than has been generally allowed. What mild steel has done in the past in the lightening of ships and the heightening of speed, we may expect to see nickel steel do—perhaps to an even more striking degree—in the future. But it must be much cheapened first. Who shall say what developments in structural matters we may see within the next ten years, when we remember that twenty years or so ago there was not a single vessel being built of steel?

This brings us to the question of cost, and undoubtedly the most striking feature of 1899 in an industrial sense has been the great rise in prices. By the rise in material, shipbuilders have been placed at a great disadvantage, for it is practically impossible to cover all material in advance when contracting to build a vessel, and, moreover, high price has been mainly caused by short supply, and short supply means irregular and delayed deliveries, to the general detriment of the operations of a yard and increase in the incidence of administrative and standing charges. As an example of the rise in cost, take steel plates. At the end of 1898 they were selling in Great Britain at £6 10s. per ton, and by the end of 1899 the price was £8 per ton. Within two years this particular item has advanced 50 per cent. Figuring upon plates we would estimate that a 5,000 or 6,000-ton boat, which in 1898 would have cost say £7 10s. per ton, could not now be built for less than £9 per ton. But other items have risen also—in fact, everything is so enhanced that the cost of building now may be taken as fully 50 per cent. more than the average cost of 1898, and perhaps from 60 to 70 per cent. more than the price at which steamers could be built two or three years ago. This enormous difference has had the natural effect of checking the demand for new ships—especially as the cost of working a steamer has been greatly increased by the large advances in bunker coals and stores. Then the costs of the British builder are now much greater than they need be, by reason of the restrictive action of the trade unions—especially the two leading unions in the industry—the Boilermakers' and Iron Ship-builders' Society and the Amalgamated Society of Engineers. It is true that amicable working arrangements exist between the employers and both these unions, and that since the great strike of 1897-98, work has gone on with unwonted smoothness. But the union regulations will not allow a maximum output to be attained, nor the fullest results to be obtained out of machine tools. In the case of the Iron Ship-builders, the restrictions, irregular working, excessive wages, and unreasonable demands of the men are a constant cause of complaint and loss to the ship-builders; but, as it is said that the union officials are sincerely desirous of reforming the methods of their members, it may be hoped that a change for the better may be effected without such a struggle as occurred with the engineers. What is certain, is that, without a complete revolution in the labour conditions of her ship-yards, Great Britain will not be able to retain her position as the premier ship-builder of the world.

It seems to be now generally admitted that in normal circumstances (1899 being exceptional in the excess of demand over supply of iron and steel), the United States can produce ship-building material at a lower cost than British makers can. That being so, there remain only the factors of applied science and labour. In the case of the former, American builders lack only the experience of the high-class British builders. In the case of the latter, America has the advantage at present in fewer union embarrassments and in the more generous use of machinery. How long that advantage may last cannot, of course, be said, but what can be said by an impartial Briton is that America does not need a Shipping Subsidies Bill to enable her to build and to own a merchant navy worthy of her commerce. She has all the elements within her own industrial resources, without dipping into the national purse. Bounties have not helped to any extent either the shipping or the ship-building of France, but antiquated navigation laws do prevent the natural development of America. That at least is how it appears to a free trader.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

VI.—THE MACHINE WORKS OF THE IMMEDIATE FUTURE.

CONSIDERING the successful shop of to-morrow, the preceding papers of this series may be said to point out certain conditions which must be met, in view of the close competition and the wide general apprehension of the vast importance of machine construction which now obtains, if future success in any branch of the art is to be hoped for.

First, the day of the large general shop, prepared to do business in all lines of machine building, has certainly passed and passed forever. It is, perhaps, true that there will continue to exist a great number of small repairing and general jobbing shops, supported by the various machine users in their immediate localities; it will always be the case, probably, that some of these small jobbing shops will, through some fortuitous conditions, develop into well appointed works producing only a limited line of work, meeting a wide demand both in price and quality; in this case the "jobbing" features of the establishment will naturally be dropped as rapidly as possible. In other cases, the small jobbing shops will give a decent support to the owner who attends closely and intelligently to the needs of his patrons, and to a small force of clever and versatile all-around mechanics under him, who prefer the variety and lack of strenuous effort of the small shop to the relentless crush towards the front in a single line, which must be the characteristic of the machine shop, light or heavy, of to-morrow.

As already clearly shown in these papers, there is a size limit of production which must do one of two things: it must either divide the shop into sharply defined light and heavy departments, or must divide the business itself into branches, separately housed and officered.

One important phase of machine-tool evolution—the geometrical evolution of regularly irregular metal surfaces, of which the gear-cutting machine affords the chief and most interesting example—has been necessarily left for an article supplementary to the series of which this paper is a summary. It will shortly be treated by Mr. Roland in a separate contribution to THE ENGINEERING MAGAZINE.

The series on The Revolution in Machine-Shop Practice began in the issue of this Magazine for October, 1899. The preceding topics have been:

The Evolution of the Tool Maker.
Development of the Automatic Screw Machine.
Application of the Turret to General Machine-Shop Work.
The Practical Limitations of Tool-Making.
Application of Automatic Mechanical Production to Heavy Work.

Whether the shop be light or heavy, it must be well lighted, well heated, well ventilated, and well provided with conveniences for the individual use of its workmen. These workmen's conveniences, now the exception—separate clothes lockers, separate washing facilities, and a good and well cooked mid-day meal at something less than actual cost—will very soon be regarded by machine constructors as absolutely indispensable, because in their absence the best workers cannot be had. The mid-day hot meal, giving a choice of various good dishes at trifling cost, is of the highest importance, and is in very successful operation in more than one instance. Perhaps these physical-life betterments of shop works which are directly profitable to the machine-shop owner may be listed in the following order. First, a white shop interior—walls white, ceilings white, all tools painted white; next, light—first, all the daylight possible, next abundant arc lights placed above reflectors directed upward; all old machine shops and many new ones are most miserably and most expensively dark; then perfect heating and ventilation, and a cheap hot meal at noon time in a comfortable room used exclusively for eating, not for smoking or lounging. These particulars give the worker a chance to work. To obtain workers of a high grade they must be clean, and must be individualized, and must not be, either in theory, treatment, or fact, mere numbered particles of a mass. The individualized worker, who is always the efficient worker, must have his own territory in the shop, his own clothes locker, his own wash-bowl, his own seat at the table, his own machine or vise, his own round of duties, his own consciousness of his own worth and value. Only a few years since what I have just said was not to be proved by existing examples. Now it is easy to refer to many examples covering every point specified.

Having thus equipped the factory so that a contented force of workers may be reasonably expected to take voluntary service in it, and to remain, the next point to consider is the best possible expenditure of animal force. Every man has within himself a certain and fixed possibility of continued exertion. Up to this limit his effort is a pleasure to himself, and hence is willingly made; beyond this limit he cannot go if he would, and it is the business of the manager and the tool-maker to see that the least possible expenditure of muscular exertion is made to produce the greatest possible return in finished product. To this end the general manager and his superintendents under him must see that the lines of movement of material in process of finishing are well planned, and facilitated by all possible aids in the way of travelling cranes and hoists of the character best adapted to the work in hand. If the shop has more than one floor (and there are those who believe that the lantern roof and gallery floors make the best known form of heavy machine shop), then there should be abundant passenger elevators, each in charge of a special attendant. Let it be fully and clearly comprehended that each workman has his fixed individual limit of willing muscular exertion, and that the farther the maximum demand of shop exertion falls below that limit the brighter and more alert the individual workman will be during his hours of service, since nothing that moves, from a locomotive, a driving belt, or a line shaft, to the chief designer of the drawing room, can be profitably worked anywhere nearly up to the point of fatigue.

By the same reasoning, which applies to the general manager with an hundred fold the force with which it applies to the shop operative—because the manager must bear a hundred cares and responsibilities where the worker bears one—limit the lines of production until the manager can feel that no one in the whole world knows more of the true theory of the production and office of his specialties than he himself knows. When the manager reaches this point, he is indeed master of the business he controls. The fewer the subjects to which the manager must direct his attention, the more fully and thoroughly he can consider each one, and the less occasion he has to pass the limit of his profitable exertion, and to do things which he is not sure it is best to do simply because he is the only one to fill the gap.

Up to certain diameter limits, labor costs of machine production can be reduced to almost any extent. Given the demand for the finished product, and the tool-maker who can reduce the original labor cost by 50 or 75 per cent. of what originally appeared to be, and perhaps at one time was, the best possible practice, never fails to appear. This is undoubtedly true of all light machine construction, the word "light" extending only up to those diameter limits within which automatic machines and fixed cutters may be available.

For the heavy shop, most of the labor-cost reductions must be made in handling, and in furnishing the fullest facilities for thoroughly testing the finished product, and so avoiding all of those expenses and highly annoying delays that so often lie between shipment by the maker and acceptance by the purchaser. Too much stress cannot be laid on the importance of long continued shop tests, of the most complete and exacting nature, carried out by thoroughly reliable experts, under the control of chief inspectors of inflexible integrity and unswerving self reliance—men who will pass nothing faulty, and yet will not cause the shop needless expense for mere academic reasons.

Much consideration has been given to reduction of labor costs by the intellectual elevation of the operative. To most shop workers, as to most men in all walks of life, books are the mere husks and chaff of past harvests, and much book learning is to all such a loathly vanity, and very little real gain has come from the establishment of shop reading rooms and all those efforts which look to a lifting of the general intellectual level of the shop worker. To every large machine shop there will, however, come some bright young minds of the two or three strongly marked classes; those who are mechanics by intuition, skilful of hand and often fine draughtsmen, making small use of books, and of comparatively limited range of action, but infallibly correct within their limits; the few of real breadth, to whom books as well as things mean much, who grasp the full scope of their art, and, delving deeply into the records, have the capacity to make the monuments of past achievements the stepping stones to higher levels of future attainment; then those youths who know the whole of their own shops and have the poise and balance of things in their heads, and so develop in limited fields those executive powers which are indispensable to the success of large works. These bright young minds the wise manager will recognize, aid, develop, and forward with sedulous care, well knowing that the most valuable to him of all of his shop products are his home-made and home-trained leading men.

It is certain that very soon American ship-building will be a vast industry. At this moment the use of 1,200 tons of steel daily in the manufacture of pressed-steel freight cars is one of the causes of the present steel famine. Sixty-five years ago it was fully and clearly demonstrated, by costly practical tests, that all the work done on common roads by horses can be done more quickly, more safely, and more cheaply by mechanically propelled wagons, and there can be no possible doubt that this closing year of the nineteenth century will see the establishment of large American machine shops for the production of automobiles, thus giving to the machine shop the construction of the ships, the construction of railway equipment, and the building of the horses and wagons for use on common roads in both town and country, this last named division of the machinery of translation being of almost incalculable magnitude. The automobile in its heaviest forms is well within the limits of full automatic tool production, and we may look to the yet-to-be-evolved American automobile factories for examples of the very fullest development of the use of automatic machine tools, producing perfectly interchangeable self-driven wagons.

EDITORIAL COMMENT

There is in many quarters a mistaken idea that nearly all, if not all, of the mines in the Transvaal are dominated by British capital, and a consequent feeling that it is greed of British capitalists for the gold of South Africa which has had much to do with the present troubles there. As a matter of fact, both France and Germany have large, and in some cases, controlling interests in Transvaal mines, and the whole movement is simply one of the natural development of a rich country by the capital of civilised Europe.

This fact is clearly brought out by a communication from M. Henri Duval, the Director of the Johannesburg branch of the French Bank of South Africa in connection with his negotiations with the French and German consuls there in regard to action for facilitating the operation of the pumping machinery in the Rand mines. The Transvaal government being especially desirous of favouring the mines in which French and German stockholders were interested, M. Duval was called upon to furnish a list of such mines. The result is sufficiently interesting to bear publication at this time, and it will be found interesting to those who have thought that it is "perfidious Albion" only who is endeavouring to get at the gold of South Africa.

M. Duval's list is appended, these being the mines selected as having sufficient French and German capital invested in them to warrant the Transvaal government in especially favouring them.

West Rand Mines, France and Germany.

York, Germany.

Violet, France and Germany.

Lancaster, Germany.

Lancaster West, Germany.

Champs d'Or, France.

French Rand, nearly all in France.

Roodepoort United Main Reef, Germany.

Princess Estate, Germany.

Durban Roodepoort Deep, France.

Roodepoort Central Deep, Germany.

Main Reef Consolidated Mines, France and Germany.

Bantjes, France and Germany.

Paarl Central, France.

Langlaagte Estate, France and Germany.

Langlaagte United, France.

Crown Deep, France.

Salisbury, France and Germany.

Jubilee, France.

City and Suburban, France and Germany.

Meyer and Charlton, Germany.

George Goch, Germany.

Henry Nourse, France and Germany.

Jumpers Deep, France.

Geldenhuis Estate, France and Germany.

Simmer and Jack, France and Germany.

Rose Deep, France and Germany.

Glen Deep, France and Germany.

May Consolidated, France and Germany.

New Primrose, France and Germany.

Witwatersrand, Germany.

Glencairn, Germany.

Ginsberg, Germany.

Branches of the East Rand, France and Germany.

New Kleinfontein, France and Germany.

New Modderfontein, France and Germany.

Van Ryn, France and Germany.

New Chimes, Germany.

Nigel, France and Germany.

* * *

The important phase of the Isthmian canal question is the apparent determination of the United States to rush blindly into an espousal of the Nicaragua project. The blindness is wilful, for the comparatively brief delay involved in waiting for the report of the Commission now at work on the Isthmus would give clear and abundant light on the whole question. It is hardly possible to resist the conclusion that the chauvinist element, aided by the mysterious pro-Nicaraguan influences so long working on the Congress, are determined to force action before the light is turned on. Perhaps it would be nearer to the truth to reverse the relations of the factions, and to say the pro-Nicaraguan influence, aided by the chauvinism which has been taught to chant, "I believe in the Nicaragua canal" as the first article of its creed.

And at present all that can be said is that facts as to the Nicaragua canal are not in possession—sufficient facts, at least, to warrant the undertaking to build the canal. Still less do they warrant adhesion to it and curt rejection of a half-completed project which the highest authorities have pronounced perfectly practicable and sufficient, and concerning which the completeness of the information and the elaborate study is nothing less than magnificent.

It is, of course, conceivable that the merits of the Nicaragua route would be so commanding as to make it advisable to abandon the work done on the other line, and begin anew. The reports of former commissions do not make this appear likely, but surely an open mind and an uncommitted judgment should be reserved until the data for a full comparison are obtained. THE ENGINEERING MAGAZINE stands, as it has always stood, simply as an urgent advocate for an examination of all the facts and the formation of an intelligent and impartial judgment.

* * *

A correspondent, with kindly concern, writes us regarding the extremely interesting map of the Panama canal which formed a supplement to our last issue. He suggests that we "have undoubtedly received numerous intimations from subscribers that this map is completely reversed," and, for his part, trusts "that this will be corrected, and he will receive a new map."

None of the suggested intimations has as yet reached us. Probably our friend, who is a Canadian, has been so accustomed to think of the Pacific Ocean as being to the westward and the Atlantic Ocean to the eastward that he looked no further. We trust that reference to any moderate-scale map will assure him that the curious upward bend in the Isthmus brings the oceans into the positions shown; that in going from Colon, on the Atlantic, to Panama, on the Pacific, via the Panama canal, one actually travels southeast—in short, that the map is correct.

REVIEW OF THE BRITISH PRESS

British Shipbuilding in 1899.

IN reviewing the progress of shipbuilding and marine engineering during 1899, *Engineering* gives some interesting and valuable data concerning what is undoubtedly one of the most important engineering industries of the United Kingdom.

There are several salient points about the shipbuilding of the past year which are interesting. In the first place, the "boom" has continued, the total for the year being 1,753,757 tons floated, an excess of 82,000 tons over the preceding year. In the second place this demand has been maintained in the face of the greatly increased prices due to high rate of wages and increased cost of material. Still more encouraging is the fact that by far the greater part of the output has been for the demands of the regular trade; the orders coming from the large companies who have recognized the need for modern ships of great size. Speculative orders for tramp steamers have formed a subordinate feature in the year's work, and the great bulk of the work has resulted from a healthful growth of legitimate demands of increasing business.

The size of vessels continues to increase, 61 of the steamers launched being more than 6,000 tons gross, the great majority of them being over 8,000 tons, and among them being included the Oceanic, of 17,274 tons, the Saxonia and Ivernia of 15,000 tons, the Saxon of 12,970 tons, and the Bavarian, of 10,376 tons.

The total number of vessels built during the year is given as 1,299, as compared with 1,211 in the preceding year. This includes small and great, 864 being under 500 tons, but these do not make more than 8 per cent. of the entire tonnage, and those vessels which may be classed as deep-sea traders make up more than 1,600,000 tons, this giving an indication of the immense importance of the industry.

When the production of past years is plotted in the form of a diagram the progress will be seen to have a general upward tendency, interrupted by sudden drops, the recovery after each period of depression carrying the curve to a still higher point than any previously attained. These drops occur at almost regular intervals of 8 years, and as the last was in 1893, the next might be expected in due course by the first or second year of the century. The points of depression, however, may also be connected with corresponding periods in general business, and it hardly seems logical to assume that there is any especial law affecting the shipbuilding industry alone. Competition, however, has arisen to a marked extent in Germany, being fostered not only by liberal mail allowances, but also by the enthusiasm which has done so much to advance engineering work in all directions in Germany. American competition has not entered the field yet, but is awaiting favourable legislation, but in the ordinary cycles of commerce a cessation of the present great activity must be expected, and there is no better time to prepare for a period of depression than at a season of prosperity like the present.

So far as the building of warships is concerned, the tonnage was slightly less than in the preceding year, being 169,492 tons, as against 193,353 tons, but the value was nearly £600,000 greater in 1899 than in 1898. The warship tonnage for the British Navy was about equally divided between dockyards and private yards, and there were more than 47,000 tons of warships built for foreign countries, while at the same time the dockyards were largely occupied in repair works and in preparing ships for commission. Naval ships, however, form only about 10 per cent. of the total tonnage, and hence the greatest commercial interest is in the development of the merchant marine.

One of the strongest evidences of the growth of foreign competition is found in the gradual decline in the proportion of foreign tonnage. During 1899 21.18 per cent. of the tonnage was for foreign owners, as compared with 24.4 per cent. in 1898, and 30 per cent. in 1896, and while this is evidence that British builders still supply a large portion of foreign trade, yet it shows that the falling off in foreign orders which commenced in 1896 still continues. This is likely to be still further the case in the present year, because a large portion of the present foreign trade comes from Germany, the country which is actively engaged in developing her own shipbuilding facilities and making every effort to retain the orders of her own people, so that further inroads may be expected.

An interesting feature in marine engineering is the proportionally higher powering of recently built vessels.

"The total horse-power of the marine machinery produced during the year is 1,540,814 indicated horse-power, which is 108,000 more than in the previous year, and works out to about 0.9 indicated horse-power per ton of steam vessels built. This is much higher than in the previous year; the explanation is only partly to be found in the number of warships included with horse-power disproportionate to tonnage, for this year there have not been an increased number of such high-powered craft as destroyers, nor have there been more engines built for old steamers or for steamers built abroad. There have been more vessels of the intermediate type, with 15 knot speed, and more also of the first-class liners. Amongst the latter the Oceanic takes first place in this, as well as in respect to speed, and here it is interesting to note that for the first time we have her horse-power stated by her builders, an interesting fact. With 27,000 indicated horse-power for a gross tonnage of 17,274, she has 1.56 horse-power per ton, while 2 horse-power per ton is the proportion in several of her competitors, the Kaiser Wilhelm der Grosse, Campania, and Lucania, St. Louis and St. Paul and the Paris and New York, but it should be remembered that her great length alone is an element which must increase the propulsive efficiency of each unit of power."

An interesting list is given of the output of a number of the leading yards, for which the interested reader is referred to the original article. An idea of the increase in large steamers may be obtained, however, from the fact that while Messrs. Harland & Wolff head the list with an output for the year of 82,634 tons, this includes only seven steamers.

Modern Water-Meters.

There is at the present time a general feeling among engineers that the old-fashioned system, or rather lack of system, of estimating water rates by the size of the connection, by the number of faucets, or by the property valuation, should be superseded by the more rational and scientific method of direct measurement. Some opposition which has arisen to the introduction of water-meters is due to ignorance, and to a poorly concealed feeling that behind it is some deep-laid plot to tax the consumer at the expense of health and comfort, a feeling that has been worked upon by unscrupulous and cunning demagogues in numerous instances. Practical experience has shown beyond a doubt that the actual consequence of the introduction of water-meters is a great reduction in waste and in the reckless neglect of proper care of appliances by a limited number of consumers, and a corresponding economy to the great majority of householders who had been previously carrying the burden of others.

The chief element in the proper use of meters lies in the selection of the meter for the work which it is to perform, and in this connection a paper presented before the Institution of Mechanical Engineers by Mr. William Schönheyder, upon the subject of water meters of the present day, with especial reference to small flows and waste in dribbles, is of much interest and value.

Mr. Schönheyder begins by discussing the various classes of meters, subdividing them as follows:

1. Low-Pressure Meters.
2. Inferential Meters.
3. Volume or Capacity Meters, without device for rendering them tight.
4. Those of the Venturi class, which have a special function.
5. Waste-detection Meters, of the Deacon class.
6. Positive Meters, or Meters which provide a space to be filled with and emptied of water, and which have some contrivance for rendering them tight, at varying pressures and under diverse conditions of service.

Each of these classes has its proper function and application and the exercise of judgment only is necessary in order to obtain satisfactory results with the appliances now to be had.

Low-pressure meters, while very accurate, have but limited use, as the entire head of water is absorbed in the passage, and it is therefore necessary to place the meter at a sufficient elevation above the points where the water is to be used to permit a proper delivery after the water has passed the meter. They are of the bucket or drum type, and measure dribbles as accurately as larger flows.

Inferential meters do not measure the flow directly, but act by causing the water to operate a fan or turbine placed in the current, the relation between the speed of revolution of the turbine and the flow being determined by calibration.

Volume, or capacity meters aim to measure the entire flow passing through them, but while consisting of water motors driven by the water passing through them, they have no provision for taking up wear or maintaining tightness, and hence it is possible for small flows to dribble through without being measured at all. They are accurate when new and when operated close to their full capacity.

The Venturi meter operates by measuring the difference of head at various points on a contracted pipe, and while unsuitable for domestic purposes, it is valuable and accurate for a station meter when operated at its full capacity, especially as it is provided with an excellent recording device.

Waste detection meters, of which the Deacon is a type, are also valuable for special purposes, furnishing a record of the flow through mains for definite periods.

Positive meters are naturally those which appeal to the engineer, and many attempts have been made to produce accurate and reliable meters of this type. Nearly all of them are piston water motors, the valve of one piston being operated by the other, there being some mechanical connection between the pistons to compel a uniform length of stroke. Mr. Schönheyder illustrates a large number of such machines, including the three-cylinder meter of his own design, and gives a number of trials to show the limits of accuracy of such devices.

It is undoubtedly correct that a meter for domestic service should measure irregular dribbles accurately, since such wastes constitute a large proportion of the whole, and this can only be done by a positive meter with tight moving parts. The mechanical features to be attained, therefore, are the use of a few working parts with tight packing, yet free from much friction, positively operated by the smallest quantity of water which can enter; and these points must not only be secured in the new device, but they must be maintained during long periods of service without repair or attention.

Such results have doubtless been attained in practice and can be attained continuously, but it must be by the use of apparatus intelligently designed to meet the conditions of actual service by engineers who appreciate the nature of the problem.

The Standardisation of Screw Threads.

There is little or no difference of opinion amongst engineers at the present time about the desirability of the unification of screw threads, although when the pioneer system of Whitworth was introduced, in the period between 1841 and 1860, many manufacturers seriously held to the view that by using a peculiar form of thread they were retaining to themselves the trade and repair work of their customers which they might otherwise lose.

At the present time there is little or no such narrowness of view, and the general introduction of standard screw-cutting devices in all parts of the world has rendered it practically necessary for builders of machinery of all kinds to use screw threads which can be matched by commercial bolts and nuts on the open market.

In view of the question of a standard system of screw threads for use in the metric system of measurements *Engineering* publishes a review of the whole subject of standardisation of screw threads, based largely upon a paper communicated to the Turin Society of Engineers and Architects by Signor Galassini, one of the Italian representatives at the Zürich International Screw Thread Congress; and the timeliness of the matter renders a discussion of the subject appropriate at present.

Whitworth's system was in general use in Great Britain by 1861, and has so remained, while in the United States the Sellers, or Franklin Institute, standard, came out in 1864, and so came into general use before the Whitworth system secured a permanent foothold there. So long as the metric-using countries purchased a large proportion of their machinery from England the Whitworth system remained standard over the greater part of continental Europe, as well as in other parts of the world to which British machinery was exported, but at the same time there has been a constant and persistent effort to introduce a standard metric screw-thread system, and with the development of machinery construction in Germany, Belgium, Switzerland, and other metric-using countries, the need of a suitable screw-thread system has become more and more pressing.

As might have been expected, the efforts of a number of independent individuals, organisations, and governments to attack such a problem without some plan for concerted action, has led to the production of a great number of systems, many of them differing but slightly from each other, and no one of them having come into anything like general use. The consequence is that at the present time we see in Germany, Switzerland, Belgium and other countries in which machine building has developed, the curious fact that tools, engines, and general machinery are designed with all parts dimensioned in the metric system with the exception of the bolts and nuts, these being dimensioned in inches and vulgar fractions thereof, and with screw threads formed upon the standard Whitworth system.

The great difficulty in the way of the adoption of a metric system appears to lie in the very number of proposed systems, and in the unwillingness of the various countries, organisations, and individuals to enter into any agreement as to the system to be adopted or as to the method of securing its adoption.

Within the last few years, however, it seems to have dawned upon those who have interested themselves in the problem, that what was really needed was, not a new screw-thread system, but some responsible organization which could command sufficient international influence to effect the adoption of a definite system into general practice. It has been fully demonstrated that this could not be effected by any national engineering society, since one country would always be unwilling to accept a standard urged by an organisation of another country, probably both a political and commercial rival, and the same feeling prevented the general acceptance of the action of any single government, however judicious or desirable.

The organisation of the International Screw Thread Congress, however, seems to be a recognition of the fact that the true method of accomplishing something has at last been appreciated, and this is further confirmed by the use of a country like Switzerland, unimportant politically, altogether neutral and free from international complications, and at the same time prominent mechanically, as a location for meetings and a basis for action.

At its last meeting in Zürich the congress practically accepted the Sauvage system, already largely used in France, making some slight modifications which serve to make it nominally the system of the International Congress, and postponing further action until a later meeting at Berne in connection with the International Congress for Railway Unification.

It is in the formulation of a metric screw-thread system that the weak feature of the metric system itself appears most distinctly. The subdivision by tenths often causes too wide a leap to be satisfactory, and a disposition to fall back upon the system of halving and quartering persists in cropping out, just as the market people in France continue to use the half and quarter litre and kilogramme, ignoring the decimal idea altogether. Of course it is evident that the decimal system may be and is used to express these values, but the use of pitches such as 1.25, 1.50, and 1.75 millimetres shows the convenience of the system of continual bisection in the formation of a series in a manner which is but thinly concealed.

The outcome of these later efforts will probably be the general adoption throughout the mechanical world of three main screw-thread systems, the Whitworth, the Sellers, and the International Metric, while as *Engineering* suggests, the demand for a fine-thread system for such work as watchmaking, the construction of mathematical instruments, and the like, will probably be filled by the Thury system, based on the metric units of measurements and devised especially for this class of work.

Ultimately the general adoption of the metric system is expected to cause the disappearance of all screw-thread systems based upon the inch, but the accomplishment of that result is probably a long way distant, and screw-cutting machinery built in England and America for use in countries where the metric system is in use will continue to be made, as now, with change gears enabling threads in either system to be made with as high a degree of precision as the relation between the two systems is practically known.

Electrolytic Copper Tubes.

With the increase in steam pressures and consequent increase in temperatures the demand for seamless copper tubing for steam connections and similar purposes has led to various attempts to produce tubes of any required diameter without the necessity of using brazed seams. Among these it is but natural that the idea of employing electrically-deposited copper should have been considered, and so long ago as 1876 experiments were made in Russia, the land where the electro-deposition of metals originated, and tubing of moderate dimensions successfully produced. The principal difficulty in practice appears to have been the granular character of the deposit, thus causing its strength to be irregular, and frequently far below that of the rolled metal, and recent efforts have been mainly directed toward the development of some method by which pure fibrous copper of maximum strength may be deposited electrically even when a high current density is employed.

Various plans have been tried to obtain a uniform and tough deposit of copper, and in a paper recently presented before the Institution of Electrical Engineers, Mr. Sherard Cowper-Coles reviews these, and describes the centrifugal method, devised by himself. The well-known Elmore process employs an agate burnisher for the purpose of consolidating the copper during deposition. When this method is used for making tubes the cathode on which the copper is deposited is slowly revolved while the burnisher traverses back and forth, producing a copper of high density, the specific gravity being as high as 9.2, and the strength 26.5 tons per square inch. The principal drawback to this process is the tendency of the copper to exfoliate under the burnisher, the pressure requiring to be regulated to a great nicety. Another method employs a sheep-skin burnisher instead of a metal one, the effect being to cover all projecting parts with a thin film of animal fat, which hinders further deposition until the surrounding depressions have been raised to the common level. Various other forms of impregnators have been employed for a similar purpose. Other methods have been devised in which the electrolyte is injected upon the copper during deposition, but none of these has as yet come into extended use.

In the centrifugal method, devised by Mr. Cowpes-Coles, no burnishing is used, but the mandrel is caused to revolve at a high rate of speed, while the copper is being deposited upon it. Several results are produced by this action. The skin friction between the deposited metal and the electrolyte keeps the copper smooth and compact, and at the same time any gas bubbles evolved at the cathode, or any impurities in mechanical suspension in the electrolyte, are thrown off by centrifugal force, and hence the principal sources of defects are removed. Porosity is largely due to the formation of gas bubbles, while excresences are mainly due to the presence of specks of foreign particles. In addition to the revolving motion which is given to the mandrel, the electrolyte is briskly circulated through the cells by an acid-proof pump, the solution being forced or pumped to a reservoir, where it is passed through a filter to rid it of all impurities in suspension.

By the employment of this method it has been found possible to produce smooth and tough deposits with the remarkably high current density of 190 amperes per square foot, the voltage being about 1 to 1.2. It is also practicable to use a hot and more acid solution than has generally been employed, this allowing a heavier current to pass at a much lower voltage than would otherwise be possible, the deposit also being much tougher than when a cold solution is used. Some copper sheet, not annealed, deposited by the centrifugal process, 0.0245 inch in thickness, broke at 433 pounds, which is equal to 22.1 tons per square inch. Hard-drawn wire made by this process has a tensile strength of 29 tons per square inch, the electrical conductivity being 99 per cent.

It is rather interesting to note that formerly copper pipes were made by bending and brazing rolled sheet copper, while at the present time it is found desirable to produce sheet copper by electrolytically depositing a seamless tube and subsequently cutting it open and flattening it out.

The development of this branch of electrometallurgy is an excellent instance of the manner in which electrical processes are modifying and in some cases revolutionizing older methods. It is authoritatively stated that more than one-third of the copper produced in the world is now electrolytically refined, one-half of the output of the United States being so produced, and nearly all the copper used by electrical engineers is refined electrolytically.

Multiple Expansion Engines.

The questions of cylinder ratios, points of cut-off, and receiver-drop have been discussed and re-discussed many times over without resulting in any definite solution of the several involved problems, and it is therefore with mingled feelings of interest and distrust that the paper of Professor R. L. Weighton before the North East Coast Institute of Engineers and Shipbuilders upon receiver-drop in multiple expansion engines is received. The paper itself handles the subject in a thoroughly careful and satisfactory manner. and details the results of trials upon an experimental engine well adapted for the purpose, and the conclusions were undoubtedly warranted by the results in the particular cases under consideration. The extent to which those conclusions are applicable to widely differing conditions remains to be seen.

The real object of the experiments was the determination of the most economical point of cut-off in the larger cylinders of multiple-expansion engines—that is, in the low-pressure cylinder of compound engines, in the intermediate and low-pressure triple expansion, and in the two intermediate and low-pressure cylinders of quadruple expansion engines. At the same time it was endeavored to determine that receiver drop between any two cylinders with which was associated the maximum degree of economy, as well as the general effects of varying amounts of receiver drop.

It is impossible here to go into the details of the trials, which were very exhaustive and which are fully described in the paper. The results are fully tabulated and also plotted in the form of curves showing the water used per hour, the brake horse-power. and the water used per brake horse-power per hour. Combined indicator diagrams for the three cylinders of the triple expansion engine are also given for various points of cut-off, thus showing the effect of varying the cut-off in the intermediate and low-pressure cylinders upon the drop, and from the data and results thus exhibited Professor Weighton deduces his conclusions.

The first and most important of these conclusions is that the one and only factor which affects materially the cut-off of maximum economy in any one of the cylinders following the high-pressure cylinder, is the ratio between the cylinder in question and the immediately preceding cylinder. In other words, the ratio between any two successive cylinders is the one factor which determines the point of maximum economy cut-off in the second of the two cylinders. This relation is expressed as follows:

$$\frac{\text{Maximum-economy cut-off}}{\text{stroke}} = \frac{R + 6.6}{6.6\,R}$$

From this it follows that the cut-off in the larger cylinders, once fixed should never be altered, whatever may be the cut-off in the high pressure cylinder, or the steam pressure employed; and automatic expansion governors, or linking-up gear should act upon the high-pressure cylinder only, if maximum economy at all powers is to be preserved.

The effect of cut-off in the larger cylinders upon total horse-power is also to be considered, and the experiments revealed a peculiar relation in this respect. As regards the low-pressure cylinder of triples, and the second intermediate and low-pressure cylinders of quadruples, maximum power cut-off in these cylinders coincides with the cut-off of maximum economy as determined by the above formula. As regards the second cylinder of triples and quadruples, maximum-power cut-off is very considerably later than that of maximum economy. A considerable variation in cut-off does not materially affect the economy, however, when the cylinder ratio is small, but when R is large there is no such permissible deviation without a consequent fall in efficiency.

Should these simple relations be found to hold good for engines widely different from those upon which Professor Weighton made his experiments the proportioning of multiple expansion engines will be greatly simplified. There will, however, doubtless be much discussion, and we trust many further experiments, upon the questions which have thus again been raised.

Waste Water from Factories.

Although much of the pollution of streams is due to the discharge of sewage the great difficulty in some localities lies in the large quantity of factory waste which must find an outlet, and which is altogether objectionable in rivers. Following out the general idea of prevention now so successfully adopted for dealing with sewage pollution, the subject of the purification of trade waste water was discussed at a recent meeting of the Institution of Civil Engineers in papers by Mr. Reginald A. Tatton and by Mr. W. O. E. Meade-King, of which an abstract is here given.

The method of purification naturally differs according to the character of the waste, and in most cases the purification may be combined with such an extent of waste-recovery as to be desirable from an economical point of view, apart from the importance of abating a nuisance. Three examples cited by Mr. Tatton will serve to show the methods which have proved satisfactory in actual practice for dealing with the particularly objectionable discharges from dye houses and wool scouring factories.

In the case of ordinary bleaching, dyeing, and finishing, it has been found that precipitation with lime and iron-alum, followed by filtration through cinder, effected a satisfactory purification. At an establishment discharging about 500,000 gallons of such waste per day two series of settling tanks were used, the greater part of the suspended matter being deposited in the first series upon the addition of lime and iron-alum, and a final settling taking place in the second series. The liquor from the tanks was clear and free from suspended matter, and the final passage through the cinder filters rendered the effluent apparently unobjectionable.

The waste water from wool-scouring is of a very polluting character, owing to the amount of grease and animal matter extracted from the wool in combination with soapy matter, and it is found desirable to keep the greasy water separate from the dye waste, in order that separate treatment may be given. The solids from the greasy water are successfully precipitated by the use of lime and ferric chloride and settled in a series of three tanks, the sludge being collected on filters of cocoanut matting, and after partial drying the oil extracted in presses, the water from the filters being discharged into the stream.

When the wastes are from the processes of calico printing, dyeing, and bleaching, the pollution is caused by alizarine, logwood, and other dyes, and by soap, starch, etc. In such cases a main settling tank of large capacity is used, from which the waste can be pumped into two precipitation tanks alternately, iron-alum being used as a precipitant. The sludge from the tanks is pumped to a sludge drying area, and the water filtered through fine ashes.

Where the water contains much dyestuffs and soap the recovery of the wastes is an important matter of economy, and it is often found better to keep the concentrated logwood liquor separate for treatment by itself.

In the case of waters from breweries and tanneries, precipitation should be followed by effective filtration or land treatment, if it is impracticable for the waste to be discharged into the sewers.

The question of cost is an important one in connection with the purification of trade wastes, and the use of salt as an aid to rapid precipitation was suggested by Mr. Meade-King. The use of rapid filtration plants was also a matter for discussion, the limited area available for putting down filtration plants often being a controlling consideration. If the material of the filter bed be so chosen as to afford a free and rapid passage while at the same time exposing the effluent to extended contact with the air for oxidation it might be possible to treat within a limited area a quantity of waste otherwise unmanageable.

The experience which, it is shown by these papers, has been gained in the treatment of trade wastes is sufficient to render it altogether apparent that there is no good reason why such wastes should be permitted to pass in their raw condition into streams to create a nuisance by pollution, and possibly endanger the health of the community. The fact that in most cases the recovered wastes possess a distinct value should aid in the enforcement of effective purification methods.

Ventilation Without Draughts.

Notwithstanding the various treatises which have been written upon the subject of ventilation, and the number of eminent engineers who have devoted themselves to this line of work, the fact undoubtedly remains that there are very few buildings which are provided with satisfactory systems of ventilation. We know about how much air is vitiated in a given time by a man or a gas burner, and we know how the vitiated air can be removed and replaced with fresh air, but when it comes to performing this apparently simple operation in practice, we nearly always make a mess of it. Sometimes we try to pull the foul air out expecting the pure air somehow to find its way in; on other occasions we try to push the fresh air in. and expect it to drive the foul air out. In either case we generally succeed in producing uncomfortable draughts and in accomplishing only very imperfectly the complete renovation of the atmosphere of the space under consideration.

In discussing this subject in a paper before the Society of Arts, printed in the *Journal* of the Society, Mr. Arthur Rigg brings out some excellent points, which are well worth reviewing.

After quoting authorities in a number of walks of life to show the necessity of providing better and more adequate ventilation, Mr. Riggs goes on to show how defective some of the most pretentious ventilating schemes have really been. The lecture rooms of the University of Glasgow, the Houses of Parliament, the new Law Courts, all are evidences of failure to accomplish the apparently simple task of providing pure and fresh air for a number of assembled people without at the same time exposing them to injurious draughts. The common method of ventilation is the vacuum system. The ordinary fire place acts to produce a suction up the chimney, and the result is the production of chilling inward draughts under the doors, around the windows, and even through the walls. The same effect is produced in those ordinary cases in which the vacuum is produced by a mechanical means. Especially is this the case when the exhausting apparatus draws the air from the upper part of the room, as is usually the case. Very commonly the area of the inlet openings, when such are provided, is by no means as large as should be the case, and the result is an increased velocity most uncomfortable and even dangerous to those who may be obliged to remain near the air inlets.

Mr. Rigg comes out plainly in favour of the pressure, or plenum system, and believes in forcing the fresh air in rather than in merely sucking the foul air out. In order to accomplish satisfactory ventilation by this system, there are several points which should be carefully considered. In the first place, the general flow of fresh air should be downward. The foul air naturally sinks, except in the limited area where it is highly heated, and it can always best be removed from below. The fresh air should be introduced as an upward current from openings above the heads of the audience, but not so high as the ceiling. It should be delivered in divided streams into the upper part of the room, so as to mix with the warm air already travelling there. Exits for carbonic acid, dust, and watery vapour should be provided at, or near to the floor level, if required. The roof or ceiling of a properly ventilated chamber should be hermetically closed. Open windows should be used only during warm weather, never in winter. Natural draughts cannot always be relied upon, and hence, when necessary, fans, furnaces, or other artificial means should be resorted to.

Mr. Rigg gives a number of examples of faulty ventilation, and shows how, by modification, in accordance with the foregoing principles, and by providing sufficient inlet area to avoid too high velocities, an ample and comfortable ventilation may be secured, while at the same time draughts may be avoided.

REVIEW OF THE CONTINENTAL PRESS

The Problem of Submarine Navigation.

THE interest which is taken at the present time in submarine boats for military purposes is evinced by the discussions which attend any public trials of such craft, and in France especially, the possibilities of such an auxiliary to naval power are at present attracting much attention.

Apart from the detailed construction of any particular boat, there is an interesting discussion of the general principles upon which successful submarine navigation must depend, appearing recently in *La Revue Technique,* and written by M. H. Noalhat.

While there are a number of special features about submarine navigation which render the problem essentially different from that of navigation at the surface, these may broadly be classified into two main questions; immersion and orientation. In his present paper M. Noalhat confines himself to the examination of the first of these, promising, however, to take up the second in a later contribution.

After enunciating the well-known principle of Archimedes as to the fact that every immersed body is buoyed up by a force equal to the weight of the volume of displaced water, and acting vertically upward at the center of gravity, M. Noalhat proceeds to consider the stability of immersion at various depths, both for a boat at rest and for one in motion. When the buoyancy is just equal to the weight of the boat it may be said to be neutral; when the buoyancy exceeds that of the boat it is positive, and when it is less it is said to be negative.

The control of the depth of immersion of a submarine boat may be based upon one or the other of two conditions; neutral buoyancy or positive buoyancy.

In the case of neutral buoyancy, the weight and the lifting force being equal, the boat theoretically remains submerged at a given depth. This theoretical condition is not completely attainable in practice, although it has been attempted many times. It is very difficult to secure exact equality between the weight and the buoyancy, and such an equilibrium, even if attained, would be disturbed by submarine currents, by variations in atmospheric pressure, and by other uncontrollable factors. The nearest approach which can be made to neutral equilibrium in practice is secured by providing a means of quickly and readily varying the weight of the boat. itself already very near a state of neutral buoyancy, thus permitting an immediate correction of any tendency to sink or rise as such may appear.

This system naturally involves the use of some variable ballast, in practice a water-ballast, which may be controlled by pumps, and some very ingenious devices have been invented for regulating the action of the pumps by the external pressure, thus causing the depth of immersion to be automatically maintained within moderate limits. The principal difficulty with such a system is found in the fact that all such devices require an appreciable time to respond to the control, and as the boat must start to sink or to rise before the pumps receive the corrective impulse, and as a still further lapse of time is necessary before a change in the ballast sufficient to affect the equilibrium is produced, the range of rise and fall may become altogether too great to be satisfactory or even safe.

When this system is applied to the regulation of the depth of immersion of a boat in motion the tardiness of response affects very materially the angle of descent or ascent, and in practice it has been found successful unassisted only when used at very moderate speeds.

The second method, that involving positive buoyancy, has been employed in a number of cases. It depends upon the provision of an excess of buoyancy, causing the boat to have a constant tendency to rise, this tendency being opposed by mechanical devices in order to enable immersion to be produced at will. This method appeals to all designers, because it possesses the valuable feature of causing the boat to rise to the surface in case of any failure of the machinery. It also gives opportunity for the introduction of devices for maintaining stability mechanically.

Various devices have been employed to produce and control immersion in boats of this type. Screw propellers on vertical axes, first tried by Bushnell in 1773, have been employed many times since; Waddington having used two screws, placed in wells situated fore and aft, while Nordenfelt placed the screws on each side. The principal trouble encountered with such devices in practice lies in the difficulty of obtaining uniform action of the two screws, the slightest preponderance of one or the other being sufficient to destroy the equilibrium of the boat.

Another method of controlling such a boat is the use of horizontal rudders, such rudders having first been used in a rudimentary fashion in 1809, by the brothers Coessin, and since 1872, in various types of automobile torpedoes. In some cases a single rudder, placed at the stern, is used, but horizontal rudders placed on each side have been found effective, these all involving a progressive motion of the boat.

The great difficulty with all methods of controlling the position of a submarine boat is that of maintaining a horizontal position, most of the plans causing a descending and ascending motion, the boat thus being generally at more or less of an angle with the horizontal. Such boats are also necessarily liable to have their equilibrium disturbed by movements within, and any shifting of weights, such as the handling of torpedoes, or much movement of occupants, may produce a perceptible effect.

In view of the experience which has been had with modern boats, there is every reason to believe that the principle of positive buoyancy, united with effective mechanical means for producing submergence, is the correct one, and when combined with a satisfactory method of orientation, or control of lateral direction, will be found superior to the older method of neutral equilibrium.

M. Noalhat's paper will be found an instructive study in connection with one of the most practical problems of modern marine science, and it is to be hoped that he will continue his further presentation of it.

Gas Power for Electric Stations.

THE development of the gas engine and the application of lean and cheap gas to motive-power purposes have both led to a widening use of gas power, and from being little more than a toy, driving job presses or turning ice-cream freezers, the gas engine has in many instances become a worthy rival of the steam engine.

The possible advantages of gas as a means of power transmission are discussed in a leading article elsewhere in this issue, and the general application of the gas engine as a motive power for electric generators forms the subject of a paper before the Hanover Electrotechnical Society, by Herr M. Krone, published in the *Zeitschrift des Vereines deutscher Ingenieure,* in which an account of the working installation at Clausthal is given.

In order to compare the operating cost of steam and gas power Herr Krone gives a computation for the cost of steam power, both with and without condensation, including interest on cost of plant, depreciation, and attendance; this estimate including also the cost of the electric plant for an installation of 100 horse power, with an equal amount as reserve. Taking all the charges into account, Herr Krone shows the cost of an electrical horse-power-hour delivered to the distributing system is, for a non-condensing engine 10.85 pfennig, or with condensation 9.97 pfennig, or for a year of 3,109 hours the cost works out, for the condensing plant, £15 10s., or about $74 per electrical h.p. per annum.

The economy to be effected by the use of gas only affects the fuel portion of the charge, since the cost of the installation, attendance, depreciation, and other fixed charges do not materially differ in the two plants, the cost of installation of the gas generators offsetting the cost of boilers to a large extent, and the difference being made up by the increased cost of the gas engines.

Making the computation on precisely the same basis as that adopted for the steam plant, the cost of an electrical horse-power-hour comes out 8.22 pfennigs, which corresponds to £12 15s., or $61.80 per horse-power per annum; gas thus showing an economy of 16.2 per cent. over steam power.

The gas power plant at Clausthal, of

which a detailed account is given, was constructed in 1897 for lighting the adjoining towns of Clausthal and Zellerfeld, having together 13,500 inhabitants, and its moderate size and excellent performance show the adaptability of this system to small electrical plants.

There are at Clausthal two gas generators of 100 h.p. each, these consisting of sheet-iron cylinders lined with fire-brick and provided with grates at the bottom, and with feeding funnels and cones at the top. Steam is furnished by small auxiliary boilers, and used in jet blowers delivering air beneath the grates, the fuel being burned to carbonic oxide, with such a proportion of water gas as is due to the steam passing through the jet blowers. The gas is passed through condensers, scrubbers, and purifiers, and delivered to a holder, from whence it is drawn by the engines.

There are two Körting gas engines of 70 h.p. each, operating normally at 140 revolutions per minute, but this speed can be increased about 15 per cent. when it is desired to charge the storage battery.

There is no especial feature in the construction of the gas engines worthy of remark except that the regulation is effected, not on the hit-and-miss system, nor by varying the proportions of the explosive mixture, but by varying the amount of the charge, the mixture remaining constant. Experience has demonstrated that a variation of 50 per cent. in the load produces less than 3 per cent. variation of speed, a regulation which places the gas engine in the same rank as the steam engine, so far as governing is concerned.

The electric generators are of the continuous-current type, also built by Körting, and are directly connected to the engine-shafts. The dynamos are each of 46 kilowatts capacity, the three-wire system being used with an operative pressure of 110 volts, the dynamos being operated at 240 to 345 volts.

The working economy of the plant is shown by the data for the year ending in March, 1899, the average output being 707 watt-hours per kilogramme of fuel, which corresponds to 2.32 pounds of mixed coke and anthracite per electrical horse power delivered to the circuit. This performance has doubtless been surpassed in certain steam plants, but only when operated on a far larger scale, and when the size of the plant is considered this result is certainly excellent.

The experience which has lately been gained in connection with the construction and operation of gas engines of more than 600 h.p. capacity should lead to a careful investigation of the advantages of gas power for electric plants before a final decision is reached, and in certain localities, at least, it may frequently be found more desirable to employ gas than steam.

Corrosion in Steam Boilers.

Much attention has been given to the subject of incrustation of steam boilers, and the properties of various feed waters, so far as the formation of scale is concerned, have been extensively discussed. The question of corrosion, however, is sometimes a matter of more consequence than that of the formation of scale, and waters which may be very suitable for boiler feed as regards scale, may still be altogether unsuitable when their action upon the metal is taken into account. This side of the question is discussed very thoroughly in a series of papers in *Le Génie Civil* by M. H. de la Coux, and from his examination, some points of much practical interest may be abstracted.

Pure water, and water containing carbonic acid. such as rain water, are powerful solvents, as will at once be seen when it is remembered that the rain, falling upon the surface of the earth and percolating through the various strata, comes out into the springs and rivers more or less highly charged with solutions of the materials through which it has passed, although many of these are but slightly soluble. In the presence of oxygen and of carbonic acid iron is powerfully attacked by water, ferric hydrate and ferrous carbonate being formed, both being subsequently converted into ferric oxide.

All waters are corrosive, but in different degrees, according to the nature of the substances which they hold in solution. These substances may be gaseous or may be solids in solution, which either when deposited as scale or by decomposition in solution, release free acids which attack the metal of the boiler.

Waters containing only gaseous corrosives may generally be purified by boiling, and those containing free acids, such as is the case with water from many mines, may frequently be neutralised, but the waters which M. de la Coux has classified as "incrusto-corrosive" require treatment varying with the nature of the dissolved substances.

The principal acids which are apt to appear and attack the interior of a steam boiler are hydrochloric acid and sulphuric acid. Most of the chlorides which are found in feed waters are too stable to undergo decomposition and liberate free acid; the exception is chloride of magnesium, which is readily decomposed by heat, oxide of magnesium being thrown down and hydrochloric acid set free to corrode the boiler. Chloride of ammonium, which may occur in waters containing organic matter, is also very unstable, and readily releases hydrochloric acid in the heat of the boiler. Chlorides of calcium and sodium are much less active, but are by no means permanent, and especially in the presence of other substances, may give rise to energetic corrosive action.

The compounds of sulphuric acid may under certain circumstances give rise to active corrosion. Ferrous sulphate alone produces no action, but in the presence of oxygen it becomes partially converted into ferric sulphate, which is itself corrosive and which also forms a basic ferric sulphate with the liberation of sulphuric acid, which latter attacks the iron of the boiler to form fresh ferrous sulphate, renewing and continuing the process. In certain localities where the water is taken from argillaceous soils it is found to contain aluminum sulphate, which behaves in the boiler in a similar manner to the ferric sulphate, so that water from such localities must be used with caution. Sulphate of copper is also found in many mine waters, and this in the presence of iron is decomposed with an exchange of the two metals, forming a soluble salt of iron with all the corrosive properties above noted.

Among the salts which are most detrimental to the durability of steam boilers the nitrates demand careful attention. Although they occur in but small quantities they are so readily decomposed by heat as to be very injurious. Ferric nitrate especially is readily decomposed into a basic nitrate and free nitric acid, which produces a deep corrosion of the plates of the boiler, forming ferrous nitrate, which passes to ferric nitrate to renew the decomposition continuously. Finally the presence of sulphuretted hydrogen, due to the decomposition of organic matter in the water, may give rise to serious corrosion, becoming oxidised to sulphuric acid in the presence of free oxygen.

M. de la Coux devotes some attention to the nature of boiler corrosion, showing that there are two distinct kinds of action, one in which isolated cavities or pustules are formed in the metal, and the other in which extended surfaces are eaten away.

From the frequent presence of calcium carbonate in the isolated cavities, some engineers have concluded that this form of corrosion was not due to the direct action of an acid, because an acid could not exist in the presence of the carbonate. A careful examination of the contents of such cavities, however, has revealed the distinct presence of acid reactions, so that no such positive conclusion can be drawn. Corrosion in isolated cavities, however, is generally produced by water charged with carbonates, liberating carbonic acid in the presence of oxygen. When an extended surface of corrosion is found it has generally occurred beneath a coating of scale, the corrosive substance having been imprisoned in the mass of the scale, this action being the more dangerous because it is not apparent upon inspection.

M. de la Coux goes into a careful examination of the behaviour of mine waters and of sea water, showing in the latter case the effect of the concentration of chloride of sodium upon the solubility of the other salts. Although the density of the salt in a marine boiler may be kept below a determined point by the use of the salinometer and by frequent blowing-off, it must not be assumed that the deposits of sulphate of calcium or the corrosion due to the sulphate of magnesium are limited thereby.

In examining the possible remedies against corrosion, either from acids or from incrusto-corrosives, M. de la Coux discusses the use of zinc, lime, calcium, carbonate, soda and potash as correctives in various cases, and gives a tabulated view of the various waters which may be found in practice, with the actions of the corresponding correctives. This table should be consulted in order to understand fully the chemical reactions involved in the various cases, but so far as the action of incrusto-corrosives is concerned the strongest emphasis is laid upon the value of the alkaline carbonates (carbonates of sodium and potassium) and of oxide of barium, not only as preventives of corrosion, but also to act against the formation of scale.

Telegraph Wires on Glaciers.

In a communication to the French Academy published in a recent issue of *Comptes Rendus,* the veteran astronomer, M. Janssen, gives some interesting information as to the insulating power of glacier ice, as developed in the telegraph work conducted in connection with the Mont Blanc observatory during the past year. These investigations were conducted by MM. Lespieau and Cauro, and the unfortunate feature of the work was the fatal accident to M. Cauro almost at the outset of the experiments.

The undertaking upon which the studies were made consisted of the connection by wire of the summit of the mountain with the Grands-Mulets, and the interesting feature of the experiment was the fact that the naked wires were permitted to lie directly upon the surface of the glacier, without any support or insulation.

The wires used were the regular French Government standard of galvanised iron, 3 millimetres in diameter, and the length of the line was about 1,700 metres, or a little over a mile, this being the distance between the terminals, and hence the length of each half of the circuit. The wires were laid directly upon the surface of the ice, being about 5 metres apart, no insulation being used even where they came in contact with the rocks for a few metres at the Grands-Mulets terminal. Having been found to operate satisfactorily with the telegraph instruments, they were tested for resistance and insulation. These measurements showed that the insulation was almost perfect. Galvanometer deflections on the line at points distant 300, 600, and 1,700 metres from the lower station were practically identical with those at the terminal, and the resistance of the line, as tested by a Wheatstone bridge, was found to lie between 56 and 57 ohms, while with perfect insulation it would have been but 59 to 60 ohms, so the loss was insignificant.

The results of these experiments, while perhaps of limited application, may yet prove of much importance in mountain exploration work, since it is shown that telegraph wires may be laid over the ice in the trail of an exploring or military party with but little labour or cost.

One point which must not be overlooked in this connection is the influence of cold upon the battery. The resistance varies notably with the temperature, probably due to the reduction in strength of the chlorhydrate of ammonia caused by deposition of the salt. Down to temperatures not lower than 16° C. the electro-motive force remains practically constant, after which the solution slowly freezes. When the mass has become solid the temperature continues to fall, and the resistance increases enormously. These points must be taken into account, especially in connection with electrical measurements made at low temperatures.

In view of the fact that the surface of a glacier is always in slow motion the permanency of a telegraph line laid upon the surface of the ice cannot be insured. M. Janssen promises some future data upon this point, which must necessarily involve observations made over a considerable period of time, but as such lines will probably be laid only for temporary purposes, this is not a matter of fundamental importance.

Hinged Masonry Arches.

In attempting to arrive at an accurate determination of the true stresses in masonry arches, two difficulties have been encountered: one, the inferiority in resistance of the mortar to that of the stone, and the consequent imperfection of the joints, and the other, the indeterminate position of the line of pressure at the key and at the springing.

If the line of pressure could be compelled to pass through certain points, just as a catenary passes through the points of suspension, the remainder of the curve could be accurately determined for any given span, rise, and loading, but otherwise the problem can only be approximately solved.

In order to enable a closer determination of the conditions existing in masonry arches to be made, the Inspector General of the Ponts et Chaussées, M. Maurice Lévy, has had a series of experiments made upon the use of poured metallic joints in connection with hinges at the key and springings, and the results of these experiments are very fully detailed in a paper in a recent issue of the *Annales des Ponts et Chaussées,* by M. H. Tavernier, from which a brief abstract of the results is here made.

It has been attempted to equalise the pressure upon the joints in masonry arches by placing thin sheets of lead therein, but the results appear to indicate that uniform contact is not attained by that method within the limits of settling and movement necessary to maintain the computed form of the curve. M. Tavernier therefore attempted to fill the joints with melted metal, thus filling the space entirely when the voussoirs were in the exact position desired, and this he appears to have succeeded in accomplishing very satisfactorily. Various metals were tried, the desired conditions being fusibility at a low temperature, combined with hardness and resistance when cold, and these appeared to be best fulfilled by an alloy of the nature of type metal, sufficient lead being used to secure fusibility and fluidity, the hardening being provided by the addition of tin and antimony.

In regard to the action of hinged joints, experiments were made to discover the extent to which friction might prevent the proper action of the hinge under pressures such as obtain in arches of considerable span and moderate rise. These experiments were made at the armor plate works at Saint Chamond, a hinged joint such as has been used in bridge work being placed upon a horizontal support and loaded with pieces of armor plate. Upon the top of the fixed load was placed a movable load of one ton, so placed that it could be rolled into different positions, while pointers attached at the hinge enabled the movement to be observed. This apparatus was tried with loads corresponding to pressures of 5,700, 8,250, 14,200, and 20,000 pounds per square inch of projected area of pin, and coefficients of friction determined for good and for imperfect lubrication, and also for non-lubricated surfaces. The results showed that by placing the centre of the pin a small distance out of the centre of the joint, a leverage corresponding to the resistance of friction could be used to correct for this action and compel the line of pressure to pass through the centre of the joint.

Having determined these points, an experimental arch was constructed at Saint Chamond, having a span of 49 feet and a rise of 2.95 feet, each half of the arch consisting of four voussoirs, with lead joints, the thickness of the voussoirs being 7 inches at the crown and springing, and 9.8 inches at the haunches. As solid abutments were not readily procured, the springings were tied together by rods, there being hinges both at the key and at the springings.

This arch was loaded gradually by direct weighting with pig-iron, the deflections at the joints being measured by multiplying levers, and although the depression of the crown at the instant of rupture was 7 inches for a total rise of only 35.4 inches, there was no sign of breaking or spalling off of stone at the joints, the failure occurring by splitting of the stone practically along the middle line of the curve.

Experiments of this sort undoubtedly add much more to our knowledge of the true action of forces in structures than theorising which may have failed to take some important factor into account, and it is to be hoped that they will be extended to still larger scale examples.

Electric Locomotives in Germany.

WHILE the steam locomotive is the natural development of the necessity of carrying the entire power-house on wheels which is involved in the fundamental idea of independent steam traction, and hence is no proper model to be followed under the wholly different conditions of electric traction, yet in the transition state between steam and electric traction the electric locomotive appears to be an intermediary. For the present, at least, electricity must be used on main lines in connection with steam, and the electric power must be provided in such a form that it can be conveniently substituted for the steam locomotive, and thus the electric locomotive comes in as an auxiliary.

The main reason for employing the electric locomotive in such a connection lies in the absence of smoke, gas, and noise, and for hauling trains through tunnels, making transfers across cities, or making up trains in the yard, much of the discomfort and nuisance unavoidable with steam can be entirely prevented.

Electric locomotives have come into use for such purposes in Germany to a marked extent, and in a paper presented before the German Society of Mechanical Engineers by Herr A. Tischbein, and published in *Glaser's Annalen* a description is given of a number of instances in which electricity has been found a helpful auxiliary.

When a definite portion of the track is to be used for electric traction, as in the case of tunnels, private sections, train-yards, and the like, the overhead trolley has been found the most convenient method of transmitting the energy, and several such installations are shown in Herr Tischbein's paper. When, however, the electric locomotive is liable to be called upon for service on any part of a railway system, the accumulator type is used, both forms having been successfully used on various German railways. The third-rail system, which has met with successful application in the United States, has not yet been applied in Germany, not being considered applicable for satisfactory use upon lines used also by steam locomotives. In some cases a combined system is employed, accumulators being provided for use when required, while the overhead trolley is used for charging and for use in yards and other places where wires can conveniently be provided.

An example of the combined construction is seen in the locomotive for the Lagerhof-Gesundbrunnen branch railway operated in connection with the main line of the Prussian State Railways. This machine is of 300 h.p. capacity, the current being supplied by three overhead wires, double roller-contact underrunning trolleys being employed, while an auxiliary storage battery of sufficient capacity to operate the locomotive at full capacity for ¼ hour is provided in order to permit trains to be manipulated at the junction of the trolley and main roads.

Shifting engines for yard use are illustrated by an example of a small engine used at Gleiwitz. This is operated by an overhead trolley of the curved sliding bar type, with an additional radial movement so that it may readily pass from one line to another, and thus pass freely about the yards where it is used.

Some locomotives of the pure accumulator type are illustrated, although the scope of this form seems to be rather limited; among these may be mentioned those for use in the sugar refinery at Noerten, these having a weight of 17 tons, and a battery capacity enabling them to be operated for an entire day without recharging.

Herr Tischbein emphasises the advantages of electricity over steam for locomotive power, calling especial attention to the absence of reciprocating parts, and consequent freedom from vibration and hammer-blows upon the rails, and shows that the use of such machines as auxiliaries will gradually lead to their extended application. The case of the tunnel on the Baltimore & Ohio Railroad at Baltimore, in the United States, and of the announced intention of the use of electric traction on the prolongation of the Orleans Railway at Paris are cited to show the progress which has been made in this respect in other countries than Germany.

The Manufacture of Armour Plate.

In the construction of the modern battle-ship the question of amour plate has become one of the greatest importance, and no department of the metallurgy of steel demands more attention.

For these reasons, if for no other, the very complete paper of M. Baclé, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* demands attention; forming as it does a treatise on the methods and products of the best European manufacturers. No attempt is made to discuss the subject from a military point of view, the side of the manufacturer rightly being considered the one of importance, another instance of the manner in which the engineer has taken a controlling position in matters military.

M. Baclé first calls attention to the contradictory qualities which are demanded in good armour plate. In the first place, it must be exceedingly tough, in order to be able to withstand the shocks and blows of projectiles without cracking or rupturing; at the same time it must possess a surface of extreme hardness, such as will cause the projectiles to be shattered by the force of the impact; while with these essential properties the plate must be free as possible from internal stresses, even though the mass may weigh 25 to 30 tons and have been produced from an original ingot weighing more than 100 tons.

These requirements involve two things as necessities of an armour plate works; a plant fully equipped with powerful special machinery, and facilities for producing the proper material or alloy upon which to work.

The early armour was made of wrought iron, but since 1880 steel has come into use, either alone or in combination with iron for certain portions of the plating, and at the present time steel is practically entirely used, either with or without some hardening alloy, such as nickel. Examples of tests of some of the earlier wrought-iron plates are given in M. Baclé's paper, showing the manner in which the metal permitted projectiles to imbed themselves without causing cracks or extended fractures. Similar results were obtained with very soft steel plates shown at the Paris Exposition of 1889, but as this steel has little if any greater resistance than wrought iron it has not found acceptance except for special purposes. These soft steel plates were followed by the compound plates of Cammell and of Brown, in which a hard steel face was combined with a tough backing, the intention being to provide a hard enough surface to fracture the projectile, while the tough back portion prevented any cracks from extending through.

With the improvements in plates, however, came improvements in projectiles and increase in gun-power, and the substitution of the Holtzer for the Palliser projectile, together with the increase in striking velocity, demonstrated that something better than existing plates must be developed if effective armour protection was to be maintained. The result was the introduction of nickel-steel by the Creusot works, followed by the addition of the Harvey process of surface-hardening in America, and still later by the improved Krupp armour, this last representing the latest and most successful process.

Having thus reviewed the development of modern armour, M. Baclé proceeds to examine the results of tests made upon the proving grounds of different countries, giving illustrations of the results of many trials. In this connection he mentions the proposed method of Director Maupeou, of the French Navy, for comparing the relative resisting power of different plates. This method consists in selecting in all cases such a striking velocity for the projectile as will insure its piercing the plate. The velocities immediately before and after piercing the plate are measured, and the difference between them enables the amount of energy absorbed in the passage of the projectile through the plate to be very accurately determined. By using plates of such moderate thickness that they are readily pierced, the relative resistance of plates produced by various processes may thus be determined. Such piercing tests, made upon plates of moderate thickness, accompanied by impact tests upon heavier plates of the same makes, might enable more reliable conclusions to be reached than otherwise possible.

After reviewing chonologically the tests which have been made in various countries from 1880 down to 1898, including homogeneous metal, both soft and hard, compound armour, nickel steel, nickel-steel Harveyized, and Krupp armour, M. Baclé concludes with a summary showing the gradual and marked increase in resisting power which has been secured during the past twenty years. This advance is best appreciated when it is seen that with modern steel armour the resistance to the projectile is between three and four times that of a wrought-iron plate of the same thickness.

The whole paper forms a treatise on the development of modern armour-plate, and with its illustrations, and with the very carefully tabulated results of important trials all over the world, it is doubtless the most complete presentation of the subject which has yet been made.

REVIEW OF THE AMERICAN PRESS

The Canals of New York.

One of the most valuable engineering documents which has been made public for a long time is the report of the Committee on Canals of New York State to Governor Roosevelt, published officially in volumes, and given very fully in abstract both in *Engineering News* and in the *Engineering Record*. The impossibility of covering fully such a bulky document in the limited space here available is evident, but there are certain salient points which demand attention, and which stand out as of wider importance than as regards the canals of New York State alone.

The first of these is the possible competition of the canals and the railways. Upon this question depends the very future existence of the canal as an economical means of transport, and until this is settled it is useless to go further. If the railways can in the near future reduce the cost of transportation on such merchandise as grain, coal, lumber, etc., to a point lower than is possible on canals, then canal transport is doomed. The first duty of the commission then was to determine the minimum cost of such transport by the competing railways. This was done by a general inquiry into the present condition of railway freight-rates and by special inquiry of the presidents of three of the important railways handling similar traffic. The result was to the effect that there is no probability of a rate of 1 mill per ton-mile for low-grade freight, and that there is every prospect that rates will be higher and not lower than at present. The rates for water transport at present are as follows: on the ocean it averages half a mill per ton-mile; on the lakes, where the vessels are smaller and the waterway restricted at places, it is about 0.6 mill; and on the New York canals, with their present greatly restricted waterways and obsolete methods, the present cost is about 2 mills per ton-mile.

If the committee is right in its assumption, then, that with proper improvement the canal rate can be reduced to two-thirds of a mill per ton-mile, there is nothing to fear from the competition of the railways.

The second point of general importance in the report is the comparison between the advantages of a ship canal for sea-going vessels and a barge canal with reshipment at the seaport. The idea of a ship canal, reaching into the heart of the country, rendering it possible to deliver crude products for export to the rest of the world with but one loading, is most attractive, but apart from the constructive difficulties as regards such a water-way, the question ot the varying character of the navigation is to be considered.

In the opinion of the committee it is not practicable to build vessels adapted for navigation on the ocean, the canal, and the great lakes so that they can be operated with commercial economy. The ocean steamer costs about $71 per net ton of carrying capacity; the lake steamer can be built for $36 per ton; while a canal steamer and three barges of similar carrying capacity would cost but $7.31 per net ton. To combine these three types into one vessel, capable of performing the several duties with the same economy does not seem practicable, and to use the higher cost vessel for the lower cost service would cost more than to break bulk once at each end of the canal.

The next point is the emphasis laid upon the fact that the efficiency of canals depends quite as much upon their management as upon their physical size, and that for successful operation it is necessary that all restrictions upon the capitalization of canal-transportation be removed; that mechanical traction be introduced instead of animal power, including the mechanical operation of the locks and lifts; and that the force in charge of the works be placed on a permanent footing, affording an attractive career to graduates of technical schools, and providing a competent engineering staff for the conduct and care of the works.

An interesting feature of the report is

that portion which deals with the recent and future development of canals on the continent of Europe, a special investigation having been made for the information of the committee. In France the water traffic has increased 140 per cent. since 1870, while the railway traffic has only increased 75 per cent. In Belgium, Russia, and Germany, the extension of canals and the canalization of rivers has been very marked of recent years, showing that in countries where the keenest competition exists both internally and externally, an effort is made to gain an advantage or at least to keep on an equality in the competition by reducing the rates of transportation, and that to accomplish this large sums of public money are spent to improve the water routes. These facts confirm the general proposition that under equal conditions of management, the water route, even in a restricted way like a canal, is cheaper than the rail route.

The recommended project for the New York canals is mainly one of increase in capacity, by deepening, widening, lengthening locks, introducing mechanical lifts, and generally increasing the capacity to accommodate barges of 1,000 tons cargo with mechanical traction.

With this increase of capacity, and with the removal of all restrictions and the introduction of efficient operating management it is believed that the water transport of low-grade freight from the great lakes to the sea can be effected at a cost which will be decidedly lower than is possible by rail.

The Progress of the Mechanic Arts.

In the course of his address upon the occasion of the celebration of the seventy-fifth anniversary of the founding of the Franklin Institute, Dr. Coleman Sellers brought out some interesting points upon the development of the mechanic arts during the existence of the Institute, and from the *Journal of the Franklin Institute* some extracts are made.

After reviewing the early history of machine-tool making in the United States and showing the tendency in America to depart from inherited custom and practice whenever improvement could be made, Dr. Sellers goes on to speak of the present methods.

"The tendency to standardize everything is peculiar to the United States. Builders of locomotives in America adopt standard sizes and types of locomotives, and are thus able to manufacture such to great advantage. Railroads in America are willing to take from the builders what has been shown to be good and effective, and when the same kind of machine is to be duplicated many times, the maker can afford to invest heavily in special gauges and special tools that decrease the amount of manual skill required in laying out the work or in working to drawings. The first time a piece of work is done, whether it be small or large, simple or complex, more time is spent upon it than after the workmen have become familiar with its construction, and certainly more time than would be required after special appliances have been invented and made to cheapen the product, especially when the men are paid for their work according to the quality and quantity turned out, and not by a fixed wage per diem.

"It has been the scientific methods introduced by the managers of the railroads, aided by the skill and perfect equipment in their workshops, that have made those great railway systems what they are. They must exercise the utmost caution in all that they undertake; every alteration or deviation from adopted standards involves so many pieces that must be changed. In regard to the simple matter of making brake-shoes for the cars, and boxes for axle journals, I know from my own experience that it was not until the introduction of machines for moulding these pieces accurately, that the best results could be obtained and the parts made exact and perfectly interchangeable. Every invention, whether it be in the foundry or in the machine shop, is cumulative, and has its effect upon other trades, and through our ingenuity and progress we have now reached a point when the whole world looks to America for certain work which it seems cannot be done to equal advantage in other countries."

The question of technical education has had much to do with the development of the mechanic arts, and of its influence Dr. Sellers says:

"We are long past the period of empirical work. The steel-makers and iron-founders now depend upon metallurgists to guide them, while every well-equipped machine shop in the country must have its staff of educated men who are able to reinforce the practical knowledge of those engaged in manufacturing by exact mathematical methods that in the early stages of our profession were limited to simple arithmetic.

"Reviewing the century's progress, one cannot but be impressed with the tendency to specialize all industries. It has been truly said that jobbing shops are and always will be a necessity, but that manufacturing establishments will lead in the march of improvement. Trades are becoming more diversified, and time, talent, and capital are being expended upon individual machines and appliances as special which were formerly but a part of the output of single establishments. To this concentration of the best thought upon special branches of all industries we may attribute much of the progress in the mechanic arts made during the past seventy-five years, which has opened the markets of the world to the products of our industry."

Mechanical Stokers.

THE desirability of substituting mechanical stoking for hand labor is a matter about which there is little difference of opinion, the principal questions arising being those of cost, expediency, and adaptability. The subject is so often complicated with matters not directly belonging to it that the paper of Mr. W. E. Snyder, recently read before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the society, is altogether welcome, treating as it does of the furnace considered apart from the boiler, as a device for the efficient combustion of fuel.

Ordinarily the performance of a furnace is complicated with that of the boiler with which it is operated, the efficiency being considered as measured by the evaporation, regardless of the fact that the evaporation is largely affected by the character of the boiler and of its setting. Mr. Snyder, on the contrary, seeks to find an expression for the efficiency of the furnace itself as a means of comparing various methods of conducting combustion, realizing that it is absurd to measure the efficiency of a device for generating heat by the ability of an entirely independent apparatus to absorb that heat.

In endeavoring to establish an independent standard of furnace-efficiency Mr. Snyder assumes that the perfect furnace delivers only gaseous products of complete combustion to the chimney, and only incombustible earthy matter to the ash-pit, and uses no more air than is sufficient to supply the oxygen to unite with the oxidizable components of the fuel. By measuring the losses which occur by passage of unburned fuel to the ash-pit, unburned gases to the chimney, and excess air admitted and carrying away heat, we are able to determine the extent to which a furnace departs from this perfect performance, and so obtain an efficiency for it entirely apart from that of the boiler to which it may be attached. Mr. Snyder gives several examples of this method of determining the efficiency of furnaces and shows how it enables the engineer to study the real value of a given furnace. If the furnace loss is low, indicating good combustion, but a low evaporation is shown by good coal, no blame should be placed on the furnace. The heat generation has been proven efficient; the responsibilty for its efficient absorption lies with the boiler.

Comparing different methods of firing, according to the above idea of furnace-efficiency, the defects of the common grate are very apparent. It permits some coal to fall through into the ash-pit, and it requires a large excess of air to enter when firing, while at the same time the chilling of the furnace prevents complete combustion, so that the losses at all the points are necessarily large. Instead of providing the essentials to good furnace economy, *i. e.*, high furnace temperature and proper air supply, there is a fluctuating furnace temperature and large volume of excess of air at times. The defects of the ordinary grate are not diminished by the use of the various shaking or other grates of special design, these only serving to assist the fireman in the work of cleaning, and in no way removing the great defect of intermittent firing through open doors.

Various principles of design have been adopted in the attempts to make a mechanical stoker which shall obviate the defects of hand firing, and apart from the saving of manual labor the object which they all have in view is the uniform and continuous supply of the fuel, together with a properly regulated supply of air, so that as perfect a combustion as possible may be secured.

The mechanical devices used in stokers may be of three kinds: One acts to spread the fuel upon the fire, another feeds it at one end, and the third feeds it up from beneath. In each of these the gaseous products are supposed to be fully consumed, either by passing over the incandescent fuel. or by passing through the bed of burning coal.

The first class is represented by several makes used in England and on the Continent, but is little used in America, where the second type, with inclined grates, is more common. In both of these good combustion can be secured, and a number of successful installations have been made, but there are certain defects which act to prevent the highest attainment of efficiency. Although the combustible gases produced by the coking of the coal are passed over the incandescent bed, which is at a temperature probably as high as 2,500° F., yet they are also obliged to pass under and near the surface of the boiler, which is not hotter than 400° F. The result is that only a partial combustion is attained, and some unburned gases go out at the chimney. The action of the open and moving grate-bars of such stokers is also defective in that much fuel falls through unburned into the ash-pit. Nevertheless such stokers are doing good work in many places, and when their efficiency is considered apart from that of the boilers under which they are placed their superiority to the ordinary grate is evident.

When the fire is fed from beneath, as in the third class above mentioned, these difficulties are modified. The combustible gases arising from the distilled coal have to pass through the fuel bed; and, if the proper quantity of air is present, they will be fairly well burned, although there must doubtless be a portion of the chilling effect of the boiler surface yet present. The solid cast floor prevents the loss of fuel, and this feature renders this type well adapted for burning inferior and finely divided fuels, so that the choice of a stoker should in a measure be governed by the character of the fuel with which it is to be used. The nature of this type of stoker renders forced draft necessary, and this feature enables the rate of combustion to be controlled by regulating the draft, while the high rate of combustion thus attained gives also a high temperature and permits a decrease in the amount of air per pound of coal.

It is evident that the laws of combustion must be observed in the design of a stoker if good results are to be obtained. The extent to which these laws have been observed can be determined by the character of the solid and gaseous products of the furnace, and when the efficiency of the furnace is determined from these data results are obtained which are comparable with those obtained in a similar manner from other furnaces. There is no doubt that in all cases, mechanical stoking, properly conducted, is better than hand firing, but it must not be expected that careless usage and neglect will conduce to good results. A higher grade of attendance is given to a first-class Corliss engine than to a common plain slide-valve engine, and what is good sense in the engine room is also good sense in the boiler room.

The Cost of High Speed Trains.

THERE has been much discussion of late about the high speeds which have been attained by express trains, both in the United States and in Europe, but the question of the cost of these high speeds is a matter about which little is definitely known. For this reason the paper of Mr. F. A. Delano, recently presented before the Western Railway Club, is of especial value, and although it relates altogether to American practice it will be found applicable in other countries as well.

The additional cost of fuel is but one of the items of increased cost, but even this item is somewhat uncertain. According to the formula of the Baldwin Locomotive Works, the increased resistance caused by running at a speed of 60 miles per hour as compared with 30 miles, would cause an increase of 62½ per cent. in fuel consumption, but practical experience shows that the actual increase is more nearly 100 per cent. This is doubtless due to the diminished economy of the engine at the higher speeds, as is shown by the indicator cards, but even if the fuel consumption is doubled the distance is covered in one-half the time, so the actual fuel cost of traversing a given distance is not altered.

The largest factors in the cost are the indirect items. "No expense is spared to prevent breakdowns or failures of any kind. Even the waste which is put in the oil boxes of cars and engines is of a special quality; the journals are burnished; the brasses are specially scraped or machined; the coal which is put on the tanks is selected coal, broken in advance so that the fireman will not be obliged to break it. The locomotive itself is looked over by the best mechanics, and the master mechanic gives a large share of his thought and atention to the condition of the engines and cars in such trains. In the superintendent's and despatcher's office special attention is given to avoid delays; in the maintenance of way department, from the roadmaster to the section man, the constant thought is to make the track safe for this special service. In other words, the entire character of the service is keyed up to a necessarily high pitch, which, while accruing in a measure to the benefit of the other service, nevertheless adds expense which it is impossible for any man to more than guess at."

A serious element in the cost of running high-speed trains is the delay which is caused to other traffic. A slow train preceding a fast one must soon be overtaken and compelled to take a side track, while a slow train following is soon distanced, and hence the fast train soon has gaps in front and behind it, throwing a large portion of track out of effective use for other purposes. Since the maximum amount of business is done by having the speed of all trains as nearly uniform as possible, it will be seen that a single fast train upsets all idea of conducting the balance of the traffic on the most economical plan, and the increased cost is properly chargeable to the fast train.

These facts have not always been considered in computing the cost of running fast trains, and while the earnings of such trains may be much larger than those of the slower trains it is questionable whether they are justified in view of the increased cost.

Apart from the immediate cost of fast trains, their introduction has acted to increase the cost of transportation in general.

It has led to the construction of larger and more powerful engines, and has educated the public as well as railway men to the point where the old-fashioned speed of 20 to 30 miles an hour is considered slow, even for freight. While this need not necessarily be considered a disadvantage, yet at the same time it is a matter which has very materially increased the general cost of railway service.

Mr. Delano, while maintaining that high speed costs heavily, was not prepared to give any definite figures on his own account, but stated that the superintendent of an important trunk line recently gave the cost of operating an extra fast train as $2.00 per train mile. Since the method by which this figure was reached was not explained it may be nothing more than a guess, but it appears to be none too high in the opinion of experienced railroad men.

It is not only the steam railways which have educated the public to a demand for high speeds. Cable traction surpassed the old horse cars only to be exceeded themselves by the electric cars, and local and suburban traffic is now as rapid as former through express trains. What the limit will be, or whether there has been a real benefit by this increase in transportation, remains to be seen. So far as trunk-line traffic is concerned it has hardly paid its cost, but in suburban transportation the increased value which local rapid transit has given to suburban property has doubtless proved a far greater indirect benefit than the cost of the service.

Another feature which appears to be altogether overlooked in Mr. Delano's paper is the value of fast trains as an advertising feature of the roads by which they are operated. From the manner in which publicity is given to the performance of the extra fast trains it is very evident that the railways find them of value in calling attention to their service, and that the general business of the road is "boomed," so to speak, by the fact that it possesses some well advertised flyer. This may not be exactly engineering, but it is business, and among the large sums expended for advertising an allowance should be made for the advertising value of the fast trains. In this respect the railroads are much like the transatlantic steamship lines, and the possession of a record-holder may sometimes cost more than it is worth so far as the especial vessel or train is concerned, and at the same time be a very valuable advertising medium to draw business to the line as a whole.

Failures in Asphalt Pavements.

ASPHALT pavements have come into such very general use, and have so many advantages that it is desirable that their weak point be fully ascertained in order that if possible improvements may be made and failures avoided wherever possible. For this reason the report of Captain Lansing H. Beach, Engineer Commissioner of the District of Columbia, is of especial value to municipal engineers for the article it contains by Mr. A. W. Dow upon the causes of failures in asphalt pavements.

The failures of asphalt pavements may be broadly divided into three classes: disintegration by cracking, disintegration by rolling or waving, and disintegration in spots.

The formation of long irregular cracks is due to contraction of the asphalt surface by cold. It is rare to find the crack in the concrete foundation, and the fact that such cracks often have their origin at iron manholes and the like shows that unequal contraction is the cause. Such cracks also occur sometimes at a joint made between a new pavement and an old one, or between one day's work and another, although the latter should not be the case if the work has been properly done. It is found that cracks appear sooner and increase more rapidly on streets with little or no traffic, the action of the traffic appearing to knead the surface together and prevent the formation of cracks. The proportioning of materials to prevent cracking depends somewhat upon the climate and the exposure of the street, a north and south street exposed to a wide range of temperature being the most difficult. The best asphalt surface to meet these conditions should be made with a sharp sand, well graded from coarse to fine, with the fine predominating and with as much asphalt cement as the sand will hold. The asphalt cement should be as soft as is practicable without having it mark too badly in the hottest weather.

Disintegration from rolling or crowding occurs when the wearing surface is too soft, or where the bond between base and binder, or between the binder and bearing surface, is defective. The traffic then pushes the surface of the pavement up into waves or crowds it toward the gutters. It is naturally greatest in streets subjected to heavy traffic, and in some such cases it cannot be entirely prevented, but it should not occur in streets carrying even a moderately heavy traffic, and should it appear it may be considered due to one or both the above causes. The concrete base should not be made too smooth, and if the binder and surface mixtures are too soft they will slide on the base. The crowding is generally supposed to be due to a soft surface, while in fact it is much more generally caused by a defective base or binder, and when proper care is taken to secure a perfect union between the parts, disintegration from this cause should not occur.

Disintegration in spots may be due to a number of causes. In a defective pavement there will always be some portions weaker than others, and in addition to this the irregular distribution of wear will naturally appear. When the surface mixture is deficient in asphalt-cement brittle spots will form in cold weather and these will be ground away by the traffic. Sometimes oil coming from the binder is absorbed by the surface mixture. rendering it soft and making it susceptible to the action of water, and such spots are rapidly worn away.

Another serious cause of deterioration is that due to the absorption of illuminating gas escaping from leaky gas pipes or mains under the pavement, this appearing to be a common occurrence in all cities having gas. The effect begins by the appearance of fine cracks, after which the pavement begins to crowd, and pieces of the surface mixture taken up smell very strongly of illuminating gas.

The asphalt is sometimes so heavily charged with illuminating gas that it can be ignited by application of a match, and in nearly every case enough gas will be given off by heating a small piece of the affected pavement in a tube, to have it flash by igniting.

There has been some doubt as to this disintegrating action of illuminating gas upon asphalt, but Mr. Dow cites in detail his experiments, which demonstrate conclusively that the asphalt absorbs the hydrocarbon gases and a little methane, the asphalt becoming much softened. The only way to stop this form of deterioration is to stop the leaks; repairing is useless, as the trouble soon reappears, and it is the source which must be removed.

An asphalt pavement may become disintegrated by water oozing up from beneath, the action being a rotting of the under portion of the surface mixture, after which the upper portion becomes crowded out by the traffic. As with gas, the remedy for this trouble is the removal of the source.

It will be seen that there are many other causes for the deterioration of asphalt pavements besides defective material, and that all, or nearly all, of these causes are preventable. Indeed it is not too much to say that better results can be obtained with poor materials carefully used, than with the best materials which have not proper care given to them. When the best materials are used, however, and the best care given as well, there is no good reason why asphalt pavements need give trouble, and a careful examination into the disintegrating of a pavement may, in many, if not most cases, be found due to causes entirely foreign to the composition of the material, causes which could be easily remedied with the exercise of a little common sense.

The Economy of Mechanical Draft.

The advantages of forced draft in steam generation have generally been supposed to rest in the better control which is given over the combustion, and the ability to meet sudden demands for steam promptly.

In a paper recently presented before the Boston Society of Civil Engineers, by Mr. Walter B. Snow, and published in the *Journal of the Association of Engineering Societies,* the question of the influence of mechanical draft upon the ultimate efficiency of steam boilers was discussed, and some points of interest upon that side of the subject were brought out.

After describing the various methods of producing mechanical draft by the plenum and vacuum systems, with details of various installations, Mr. Snow proceeded to discuss the several elements of efficiency. Taking a case of a plant of 2,400 horse-power of modern water-tube boilers, equipped with economizers and set with chimney draft and also with mechanical draft, all other things being assumed equal, it appears that there is a saving in first cost of $6,400 on a total cost of $79,100, by the use of the mechanical draft instead of the chimney. Again the employment of mechanical draft will permit the use of deeper fires and a higher rate of combustion, so that the full actual capacity will be obtained with boilers of but 2,000 horse-power capacity under the lighter draft, and with equal economy, so that a further saving of one-sixth of the first cost of boilers may be made.

Turning now to operative costs, it appears that with mechanical draft properly applied, a large portion of the heat which escapes up the chimney with natural draft may be saved. The actual power required to operate the fan is only about one-seventy-fifth that required to produce the same draft in a chimney by the ascending force of a column of heated air. The remainder of the heat may therefore be saved by the use of suitable heat abstracting devices, and this is the real source of the economy of mechanical draft.

In other words, by the use of the economizer for heating the feed-water, and of the air heater for heating the air supplied to the furnace, the waste of the flue gases may be reduced to only 5 per cent. of the total heat value of the fuel. The economy due to better combustion caused by the higher furnace temperature is also a feature of the use of mechanical draft as well as the closer regulation of the air supply to the actual demands of the combustion. When to this is added the ability to burn low-grade fuels at good rates of combustion it will be seen that the opportunities for economy are great.

It is evident from the points which have thus been made, that the advantages of mechanical draft are not so much those which are inherent in the system as those which may be added to it or introduced because of it. Theoretically the furnace has no way of knowing how the air which it receives is brought to it. Practically it is possible so to bring the air that it may be better applied, and better controlled, and that less heat need be wasted, and more heat may be applied to useful work. These things the mechanical draft cannot do of itself, but it can render it possible for them to be done. Like many other good things, it requires to be set to work with judgment and kept at work with intelligence, and under such conditions it will do good work.

The Automobile Movement.

In discussing the different phases of the automobile movement in different countries Mr. M. C. Krarup, in the *American Machinist,* endeavors to discover why the United States has not taken the same advanced position in that line of industry as it has in other departments of applied mechanics.

It must be remembered that the department of automobilism which has advanced to the highest position on the Continent is that of light pleasure vehicles, suitable for the pastime of a leisure class in countries where the roads and streets are of the best. Under such conditions the development of the petroleum and gasoline motor, and their application to the pleasure motor-vehicles rapidly attained a high degree of popularity, although it has failed to meet with the same enthusiastic reception in America.

That this state of affairs is likely to work injury to the cause of automobile traction in the United States need not be feared, on the contrary it will probably only serve to cause its greater progress along other lines. At the present time the requirements for an automobile vehicle are that it should be capable of supplanting animal power for transportation purposes on common roads. How this can best be done is a problem for the engineer and the mechanic to solve, and with the advantages of American automatic machinery and the widely diffused knowledge of its proper use, and with the full knowledge of the difficulties to be overcome in practical operation, there is every reason to believe that American designed vehicles, not imitations of foreign machines intended for an entirely different service, will prove entirely adequate to meet the conditions.

It is suggested that the line along which development can best be undertaken is that of the separate tractor, for attachment to vehicles of the ordinary sort, and there is no doubt that this idea lends itself especially to the plan of systematized construction so necessary for commercial success. Thus the automobile of to-morrow may be a combination of a motor or tractor, and a vehicle, while the automobile of today is a full-fledged self-propelled vehicle, a sort of infant prodigy, overgrown, and without the necessary stamina to endure the tests of life and the give-and-take of commercialism.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w* a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr* a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill Illustrated; W Words; Anon Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris
Bulletin of Dept. of Labor *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Apartment Houses.

The Design of a Modern Apartment House. Illustrated description of the various portions of a mechanical plant which must be taken into consideration in planning such a structure, as exemplified in a New York apartment house. 3000 w. Eng Rec—Jan. 20, 1900. No. 31995.

Church.

The Mormon Tabernacle, Salt Lake City, Utah. W. P. Hardesty. Illustrated description of this unique structure, its large timber arches, methods of erection, and its heating and cooling system. 2200 w. Eng Rec—Jan. 27, 1900. No. 32089.

Domes.

The Dome as the Basis of an Architectural System. Arthur Bolton. Read at a meeting of the Archt. Assn., London. An interesting paper, giving a critical survey of past methods, many illustrations and suggestions, and also editorial. 13500 w. Builder—Jan. 20, 1900. No. 32224 A.

Exposition.

The Machinery Hall and the Building for Chemical Industries (Palais de la Mécanique et Palais des Industries Chimiques). René Weil. Devoted especially to a description of the structural framework and the methods of erection of these important buildings of the Paris Exposition. Two articles. 2 plates. 4500 w. Génie Civil—Dec. 30, 1899, Jan. 6, 1900. No. 32105 each D.

The Monumental Entrance at the Place de la Concorde (Entrée Monumentale de la Place de la Concorde). Alfred Boudon. A description of the main entrance to the Paris Exposition, with a plate showing details of construction, and numerous views, giving the present condition of the work. 2000 w. 1 plate. Génie Civil—Dec. 16, 1899. No. 32100 D.

Mausoleum.

The Somerton Hills Mausoleum. Illustrated description of a receiving vault having an unusual arrangement of double walls and roofs to obtain good circulation of the air. 1100 w. Eng Rec—Dec. 30, 1899. No. 31674.

Public Building.

The New Home of the New York Supreme Court of Appeals. Illustrated description of an elaborate building in New York, particularly planned to expedite judicial procedure. 1500 w. Eng Rec—Jan. 6, 1900. No. 31771.

Structural Ironwork.

Details of Structural Iron and Steel. Information with regard to this work that may be applied in practice. Part first begins the study of materials. Ill. 2500 w. Builder—Jan. 6, 1900. Serial, 1st part. No. 31942 A.

Trussed Roof.

Reconstructing a Trussed Roof. Illustrated description of the methods adopted in remodeling a heavy roof of a St. Louis synagogue. 1000 w. Eng Rec—Jan. 6, 1900. No. 31768.

Underpinning.

Underpinning Shop Walls. Illustrated description of the different methods employed in supporting the walls of a shop engaged in heavy manufacturing while a tunnel was being driven in sandy soil near by. 1200 w. Eng Rec—Jan. 13, 1900. No. 31887.

Warehouse.

The Export Sugar Warehouse at the Port of Dunkirk (L'Entrepôt Reél des Sucres Indigènes du Port de Dunkerque). A. Boudon. A detailed account of this important structure, with especial reference to the construction of the foundations in loose sand. 2000 w. 1 plate. Génie Civil—Dec. 23, 1899. No. 32102 D.

HEATING AND VENTILATION.

Air Ducts.

Dangerous Air Ducts. Abstract of a paper by John Gormly, read at meeting of Heat. and Ven. Engs., describing construction liable to distribute sewer air through a building. 600 w. Eng Rec—Jan. 27, 1900. No. 32090.

Blower System.

Condensation of Steam in Blower Systems of Heating. Reviews experiments by R. C. Carpenter with a 48-in. blower, heater coils and engine. 2500 w. Eng Rec—Jan. 27, 1900. No. 32091.

Boiler Rating.

The Rating of Boilers for Heating Purposes. Describes experiments by John Mackay and gives two tables from which the sizes of boilers can be determined having given the amount of radiation to be supplied and the rate of coal consumption. 1400 w. Eng Rec—Jan. 27, 1900. No. 32092.

Boiler Shop.

Heating a Locomotive Boiler Shop. Tells of the successful application of a heating system and gives diagram showing effect of velocity in increasing relative condensation in heater. 600 w. Loc Engng—Feb., 1900. No. 32240 C.

Boilers.

House-Heating Boiler Capacities. Opinions of experts as to desirable commercial ratio between steam and hot-water boilers. 9000 w. Heat & Ven—Dec., 1899. No. 31696.

Forced Ventilation.

Mechanical Ventilation and Heating by a Forced Circulation of Warm Air. Walter B. Snow. Lecture delivered before the Engs' Club of Yale University. A description of this system, with information concerning methods, costs, etc. Ill. 3500 w. Yale Sci M—Jan., 1900. No. 31858 C.

Heating Water.

The Computation of Hot Water Generators (Berechnung der Warmwassererzeuger). E. Brauss. Devoted to apparatus for producing warm water for bath and household use, whether heated by steam coils or by direct firing. 1800 w. Gesundheits-Ingenieur—Dec. 15, 1899. No. 32152 B.

Hot Water.

Central Station Heating in Connection with Electric Lighting Plants. W. H. Schott. Read before the Northwestern Elec. Assn. Advocates the installation of a hot-water system. 700 w. Elec Rev, N. Y.—Jan. 24, 1900. No. 32086.

Pottery.

Ventilation and Heating of the Rookwood Pottery, Cincinnati. Illustrated description of the mechanical plant which is relied on for the entire heating of a pottery devoted exclusively to the highest branches of ceramics. 1300 w. Eng Rec—Jan. 13, 1900. No. 31888.

School-House.

Ventilation and Heating of a Baltimore School-House. Illustrated account of the system of mechanical draft heating, which can be adopted where the climate is temperate. 1200 w. Eng Rec—Jan. 6, 1900. No. 31770.

Hot-Air Furnaces for Small School-Houses. A statement of the opinions held in Boston, New York, Chicago, and Philadelphia, all being in favor of hot-water or steam heating. 1000 w. Eng Rec—Jan. 20, 1900. No. 31994.

Stoves.

The Care of Stoves for Household Warming (Beobachtung und Wartung Unserer Zimmeröfen). Erwin Nicholaus. Discussing the dangers attending the use of the porcelain stoves so common on the Continent, especially with regard to the production of suffocating gases. 5000 w. Gesundheits-Ingenieur—Dec. 31, 1899. No. 32153 B.

Ventilation.

The Value of Ventilation (Der Wert der Ventilation). H. C. Nusbaum. A review of a recent work by Dr. Krieger, discussing at length the importance of proper ventilation of public school houses, as well as suitable means for accomplishing the result. 4000 w. Gesundheits-Ingenieur—Dec. 15, 1899. No. 32151 B.

Ventilation Without Draughts. Arthur Rigg. Discusses various systems, and gives the author's views of essentials to efficient ventilation. General discussion. Ill. 10000 w. Jour Soc of Arts—Jan. 19, 1900. No. 32206 A.

PLUMBING AND GAS FITTING.

Frozen Pipes.

Frozen Boiler Connections. Describes the thawing of the connections to a kitchen boiler, and water back. 1200 w. Met Work—Jan. 13, 1900. No. 31878.

Manila.

Sanitation in Manila. C. W. Iredale. Illustrated description of the conditions and the plumbing work found there. 2000 w. Dom Eng—Jan., 1900. No. 32002 C.

Nipples.

Nipple-Cutting and Threading. Orion Tutt. Illustrates and describes the work. 3000 w. San Plumb—Jan. 1, 1900. No. 31838.

Office Building.

Plumbing in the Dun Building, New York. Illustrates and describes the work in a 15-story office building in which the required pressure on the pipes is afforded by compressed air cylinders in the basement, rather than tanks on the roof. 1400 w. Eng Rec—Jan. 20, 1900. No. 31996.

Public Baths.

The Public Baths of Bilston, Staffordshire, England. James H. Fuertes. Illustrated description of the arrangements of an establishment designed to accommodate 4,000 people per week. 700 w. Eng Rec—Jan. 20, 1900. No. 31993.

MISCELLANY.

Fire Prevention.

Fire Prevention in 1899. Editorial on the paper of Thomas Blashill, and the lessons learned from tests and experience. 4200 w. Engng—Dec. 22, 1899. No. 31-724 A.

The Architect in Relation to Fire Prevention. Thomas Blashill. Abstract of paper read at meeting of the Roy. Inst. of Brit. Archts., with discussion. Considers progress and methods. 8500 w. Builder—Dec. 23, 1899. No. 31711 A.

Fireproofing.

An Unscientific Inquiry Into Fireproof Building. Russell Sturgis. A discussion of what may be done to make buildings more truly fireproof, what restrictions should be maintained, etc. Ill. 10000 w. Arch Rec—Jan., 1900. No. 32245 C.

CIVIL ENGINEERING

BRIDGES.

Atbara.

The Atbara River Bridge. Richard Khuen, Jr. A brief account of the events that led to the construction, and of the negotiations, with illustrated description of the engineering features. 5500 w. Pro Engs' Club of Phila—Dec., 1899. No. 31-777 D.

Drawbridge.

An Elevated Railway Drawbridge in Boston. An illustrated description of a new street bridge, built at a cost of about $1,500,000. 1000 w. St Ry Jour—Jan. 6, 1900. No. 31802 D.

France.

Some Recent French Bridges (Einige Neuere Französische Brückenbauten). Herr von Frahm. A general review of recent structures, describing the Mirabeau and the Alexander bridges in Paris. the Viaur viaduct, and various railway bridges. Two articles. 6000 w. Stahl und Eisen—Dec. 1, 15, 1899. No. 32143 each D.

Long-Spans.

Long-Span Bridges. William H. Burr. An illustrated discussion of the design of such bridges. Also brief general discussion. 6500 w. Pro of Engs' Club of Phila —Dec., 1899. No. 31776 D.

Paris.

New Railway Bridges in Paris. Illustrated description. 1800 w. Engr, Lond —Jan. 5, 1900. No. 31917 A.

Railway Bridge.

The Davenport and Rock Island Bridge Over the Mississippi River. Illustrates and describes the general details of the latest bridge to be constructed across the Mississippi River, giving also its history. 3800 w. Eng News—Jan 11, 1900. No. 31866.

Short-Spans.

Short-Span Railroad Bridges. Illustrated description of some structures designed for unusually high loads and very low unit stresses; includes a description of special templates for reaming. 1200 w. Eng Rec—Dec. 30, 1899. No. 31667.

Suspension.

An Old Chain Suspension Bridge. Malverd A. Howe. Data relating to the old chain bridge crossing the Merrimac River near Newburyport, Mass. Ill. 700 w. R R Gaz—Jan. 5, 1900. No. 31760.

Tugela River.

The New Colenso and Frere Bridges. Illustrated descriptions of bridges over the Tugela River in South Africa, being made in England to replace those destroyed by the Boers. Also account of the rapid work. 800 w. Engr, Lond—Jan. 19, 1900. No. 32212 A.

Vibrations.

A Study of the Vibrations of Bridges (Etude des Mouvements Vibratoires dans les Ponts). E. Lebert. A mathematical analysis of the vibratory actions in single-span girder bridges and in suspension bridges in which the floor simply rests upon the piers. 15000 w. Ann des Ponts et Chaussées—3 Trimestre, 1899. No. 32-122 E + F.

Victoria Bridge.

The Victoria Bridge Over the Dee at Queensferry. Thomas Walter Barber. Read before the Inst. of Civ. Engs., England. Describes a telescopic or rolling girder bridge. 2000 w. Ir & St Trds Jour—Dec. 30, 1899. No. 31870 A.

Y-Bridge.

The Zanesville, O., Timber Howe Truss Y-Bridge, Built in 1831-2. Illustrates and describes an interesting wooden bridge crossing the Muskingum and Licking rivers at their junction. 1000 w. Eng News—Jan. 25, 1900. No. 32069.

CONSTRUCTION.

Barcelona.

Provincial Public Works, Barcelona (Obras Publicas Provinciales, Barcelona). Victoriano Felip. An argument for greater activity in the planning and construction of highways, water-works, and other public works demanding attention. 6000 w. Revista de Obras Publicas—Jan. 4, 1900. No. 32188 D.

Croton Dam.

The Foundations of the New Croton Dam. Charles S. Gowen. Deals with all the features of the work pertaining to the foundations, giving illustrations, sections and plates, and account of work. 18500 w. Pro Am Soc of Civ Engs—Jan., 1900. No. 32050 E.

Docks.

Floating Dry Docks in America. Waldon Fawcett. A brief account of the docks already acquired and in process of construction. 1200 w. Mod Mach—Jan., 1900. No. 31660.

The Construction of the Third Graving Dock at Missiessy (Travaux de Construction du 3me Bassin de Radoub de Missiessy). M. Guiffart. An account of the new graving dock at the port of Toulon. A caisson of structural and sheet iron was first constructed and filled with masonry. 10000 w. 3 plates. Ann des Ponts et Chaussées—3 Trimestre, 1899. No. 32120 E + F.

The Lesson of Timber Dry Docks. A statement of the relative prime cost of timber and masonry docks and of their maintenance, from the records of the U. S. Navy Department. Indicates that masonry docks are much cheaper in the end. 1400 w. Eng Rec—Jan. 13, 1900. No. 31879.

The Reconstruction of a Dry Dock. Illustrated description of the methods employed in building an old timber dock in the Brooklyn navy yard into a concrete dock. 1400 w. Eng Rec—Jan. 20, 1900. No. 31989.

Drainage.

Erection of a Drainage Plant. An illustrated account of the erection of a plant at Port Mourant, Berbice, British Guiana. 1700 w. Engr, Lond—Jan. 5. 1900. No. 31916 A.

Dredging.

The Measurement of Dredged Materials. A description of the investigations at Buenos Ayres to determine the relation between place and scow measurements. 1500 w. Eng Rec—Jan. 6, 1900. No. 31-773.

Excavation.

A Belt Conveyor for Foundation Work. Illustrated description of the method of excavating the site of a large power house by means of wheel-scrapers emptied through chutes on a belt conveyor placed in a trench and discharging outside the lot limits. 900 w. Eng Rec—Jan. 13, 1900. No. 31881.

Lighthouse.

The Construction of the Eckmuhl Lighthouse (Construction de l'Edifice du Phare d'Eckmuhl). M. Duperrier. Devoted especially to the construction of the tower and buildings, and to the general and ornamental features. 5000 w. 1 plate. Ann des Pont et Chaussées—3 Trimestre 1899. No. 32121 E + F.

Masonry Joints.

Masonry Construction with Cast Metallic Joints (Maçonneries avec Joints Métalliques Coulés). H. Tavernier. A study of the construction of poured metallic joints for use with masonry arches for the control of the line of pressure. Experiments with the trial arch at Saint Chamond are discussed. 16000 w. 1 plate. Ann des Ponts et Chaussées—3 Trimestre 1899. No. 32119 E + F.

Roads.

Country Roads (Caminos Vecinales). Discussing a proposition that the people of Segovia, Spain, be allowed to build needed roads without securing government consent, which, it is claimed, is withheld. 3000 w. Revista de Obras Publicas—Dec. 14, 1899. No. 32185 D.

Shore Improvements.

Shore Improvements at Blackpool. Illustrated description of the construction of a new promenade, sea wall, etc. 1000 w. Engng—Jan. 19, 1900. No. 32213 A.

Stresses.

How to Determine the Stresses in Scissors Trusses. F. E. Kidder. An explanation of the peculiarities in the application of the method for determining stresses in this type, which is much used in roofing. Ill. 2000 w. Archts' & Builds' Mag—Jan., 1900. Serial, 1st part. No. 31740.

Structural Ironwork.

See Architectural Engineering, Construction.

Trussed Roof.

See Architectural Engineering, Construction.

Tunnel.

The Simplon Tunnel. Brief account of machines used in the work and methods by which it is hoped to complete this great work in less than contract time. 700 w. U. S. Cons Repts, No. 639—Jan. 27, 1900. No. 32099 D.

The Tunnel Under the Spree, Between Stralau and Treptow, near Berlin (Der Spree-Tunnel zwischen Stralau und Treptow bei Berlin). With plan and profile of the tunnel and illustrations of the method of operating the shield and conducting the work. 1800 w. Glückauf—Jan. 1, 1900. No. 32160 B.

The Turchino Tunnel (Le Tunnel de Turchino). A description of the recently completed tunnel on the Genoa-Ovada-Asti railway, by which connection is made with the Mont Cenis route to Switzerland and France. A profile and sections are given. 2000 w. Génie Civil—Dec. 23, 1899. No. 32104 D.

HYDRAULIC AND MARINE.

Bilbao.

The Port of Bilbao (Puerto de Bilbao). A description of the breakwater, built under royal order of June 29, 1888. It is constructed of stone and cement and situated at the west of the outer harbor, and is 1,450 metres long. Serial, Part I. 3000 w. Revista de Obras Publicas—Dec. 14, 1899. No. 32186 D.

Breakwater.

The Reaction Breakwater as Applied to the Improvement of Ocean Bars. Continued discussion of paper by Lewis M. Haupt. 4200 w. Pro Am Soc of Civ Engs—Jan., 1900. No. 32053 E.

Canals.

Canada's Improved Canal System. On

the canal schemes aiming to divert the trade of the lakes from New York to Montreal. 2000 w. Engng—Dec. 22, 1899. No. 31725 A.

Concerning the Actual Condition of the Panama Canal. Charles Paine. The testimony of an eye-witness as to the advanced condition of the work at Panama at the present time and of the advantage of completing this undertaking rather than the commencement of a new work. With valuable topographical map. 3500 w. Engineering Magazine—Feb., 1900. No. 32191 B.

Opening of the Chicago Drainage Canal. A brief account of the opening on January 2, with short review of the work. 1400 w. Fire & Water—Jan. 6, 1900. No. 31774.

Opening of the Chicago Drainage Canal. Brief account of the letting of the river water into the canal, with outline of the work, and remarks made by Isham Randolph. 1000 w. Eng News—Jan. 11, 1900. No. 31865.

The Canals of Canada. Arthur Weir. From a paper read before the Applied Science Students of McGill University. Canal history and canal engineering. Ill. 4000 w. Can Engr—Jan., 1900. Serial. 1st part. No. 31949.

The Chicago Drainage Canal. Edwin O. Jordan. Brief review of this work, now nearing completion, and questions relating to it. 3000 w. Rev of Revs—Jan., 1900. No. 31756 C.

The Improvement of a Portion of the Jordan Level of the Erie Canal. William B. Landreth. An illustrated description of the difficulties encountered and the methods used in overcoming them. 4700 w. Pro Am Soc of Civ Engs—Dec., 1899. No. 31704 E.

The Transformation of the Lateral Canal of the Loire (Transformation du Canal Latéral à la Loire). E. Rouyer. A full account of this important engineering work, with views of the aqueducts, locks, and bridges. A map and profile of the canal are given, and dimensioned drawings of important details. 2500 w. 1 plate. Génie Civil—Jan. 13, 1900. No. 32107 D.

Drilling.

Exploration for Bed-Rock at Gila River Dam Sites with Diamond Core Drills. J. B. Lippincott. Illustrates and describes interesting investigations for the purpose of locating sites for reservoirs, thus furnishing water to irrigate the dry lands of Arizona. 2200 w. Eng News—Jan. 18, 1900. No. 31974.

Filters.

A Russian Report on Mechanical Filters. Review of the report made to the Moscow city officials by N. P. Simin, advising the adoption of mechanical filters, and advancing suggestions for their improvement. 800 w. Eng Rec—Jan. 20, 1900. No. 31988.

Test of a Mechanical Filter. Discussion of the paper by Edmund B. Weston. 4000 w. Pro Am Soc of Civ Engs—Dec., 1899. No. 31705 E.

Test of a Mechanical Filter. Continued discussion of paper by Edmund B. Weston. 2700 w. Pro Am Soc Civ Engs—Jan., 1900. No. 32051 E.

Great Lakes.

Report of the Deep Waterways Board on the Regulation of the Great Lakes. An abstract of the conclusions of the Board of Engineers appointed by Congress, as given in a preliminary report. Also editorial comment on this stupendous project for improving lake navigation. 4200 w. Eng News—Jan. 4, 1900. No. 31744.

The Lake Erie Regulating Weir. A description of the barrage which it is proposed to build across the foot of Lake Erie to maintain a fairly uniform depth of water in the Great Lakes. 1200 w. Eng Rec—Jan. 6, 1900. No. 31772.

Incrustation.

The Incrustation of Iron Pipes. Illustrated review of papers before the Inst. of Mech. Engs. on methods of removing tubercles and sediment in iron pipe, with the results of the cleaning on the discharge. 5100 w. Eng Rec—Dec. 30, 1899. No. 31673.

Irrigation.

Irrigation in Jeypore State. Describes the type of heavy earth dams, built where labor alone is cheap, which are afterwards fitted with masonry core walls when they appear necessary. 2200 w. Eng Rec—Jan. 13, 1900. No. 31886.

Laboratory.

The Hydraulic Laboratory of Lafayette College. Illustrated description of a new laboratory for the demonstration of hydraulics before classes, and for experiments by students. 3000 w. Eng Rec—Dec. 30, 1899. No. 31668.

Lead Poisoning.

The Action of Water on Lead, Tin, and Zinc Service Pipes. Facts from H. W. Clark's review of investigations made by the Massachusetts Board of Health. Also short editorial. 1000 w. Eng News—Jan. 4, 1900. No. 31743.

Lift Locks.

The Lift Lock Near Henrichenburg, Germany. Illustrated description of a lock with a lift of 53 ft., which consists of a tank on five vertical floats in deep pits, the motion being regulated by vertical screws driven by electric motors. 1800 w. Eng Rec—Jan. 13, 1900. No. 31885.

Nile.

The Utilization of the Nile. Illustrated description of the barrages at Assuan and Assuit, designed to pass great volumes of water through sluices if necessary. Also describes a system of cast-iron sheet piling. 1300 w. Eng Rec—Dec. 30, 1899. No. 31672.

Obstruction.

The Location of Pipe Obstructions by Sound. Illustrated explanation of the method of ascertaining the location by the use of a chronograph and pistol shots. 800 w. Eng Rec—Dec. 30, 1899. No. 31-671.

Power Canal.

The St. Lawrence Power Plant. Illustrated description of the methods adopted at Massena in cutting a canal about three miles long, for developing 150,000 h.p., with an account of the concrete foundations of the power station. 5000 w. Eng Rec—Jan. 6, 1900. No. 31764.

Purification.

The Purification of Water After Its Use in Manufactories. Two papers read at a meeting of the British Inst. of Civ. Engs. Reginald A. Tatton considered the condition of the Mersey and Irwell watershed; and W. O. E. Meade-King gave an account of experiments to correct the evil. 1200 w. Col Guard—Jan. 19, 1900. No. 32235 A.

Reservoirs.

The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume. Continued discussion of paper by Leonard Metcalf. 800 w. Pro Am Soc of Civ Engs—Jan., 1900. No. 32-052 E.

The Wachusett Reservoir. Illustrated description of the methods employed in stripping a basin 8½ miles long, 2 miles wide at one place, and 6.6 sq. miles in area. Also describes a method of sinking 51-ft. sheet piles with a water jet. 4000 w. Eng Rec—Jan. 20, 1900. No. 31986.

Riparian Rights.

The Rights of Riparian Owners. Editorial discussion of the rights and liabilities as affected by the principles of common law relating to surface waters. 3000 w. Engng—Jan. 5, 1900. No. 31926 A.

River Improvement.

The Improvement of the Chicago River Necessary for the Drainage Canal. E. T. Ericksen. Illustrated description of this interesting engineering work. 5200 w. Wis Engr—Jan., 1900. No. 32015 D.

River Pollution.

A National Investigation of River Pollution. A statement of the importance of a national study of the subject and of avoiding irresponsible appeals calculated to cast ridicule on national sanitation. 1000 w. Eng Rec—Dec. 30, 1899. No. 31-666.

The End of River Pollution in Connecticut. A statement of the grounds on which the Connecticut Supreme Court has forbidden the pollution of rivers by sewage. 1200 w. Eng Rec—Jan. 20, 1900. No. 31985.

Rivers.

River Hydraulics. Continued discussion of paper by James A. Seddon. 2000 w. Pro Am Soc Civ Engs—Jan., 1900. No. 32054 E.

Settling Basin.

Reinforcement of the Walls of the Kansas City Settling Basins and the Use of a Coagulant to Aid Clarification. W. Kiersted. Illustrated description of the work, and of the method of clarifying now in use. 3000 w. Eng News—Jan. 4, 1900. No. 31742.

Sluices.

Sluices of the Betwa Canal Head and Weir. Robert Macalister. Descriptive. 700 w. Prac Engr—Jan. 12, 1900. No. 32023 A.

Stand Pipe.

Stand-Pipe Failure at Collingswood, N. J. Illustrated description of a failure due to the accumulation of ice in the top of the pipe, which caused a vacuum when the water was drawn down. 350 w. Eng Rec—Jan. 20, 1900. No. 31990.

Stream Regulation.

Stream Regulation by the Use of Piling (Flussverabauung nach dem Pfahlbau-System). A. Schindler. A discussion of a method of regulating and improving the beds of streams by forming an outline of piling to be filled in by the débris. Serial, Part I. 2000 w. Schweizerische Bauzeitung—Jan. 6, 1900. No. 32140 B.

Tides.

A Study of the Action of the Tides in the English Channel (Etude du Régime de la Marée dans la Manche). M. Bourdelles. An exhaustive examination of the channel tides, with hydrographic maps and tables. 15000 w. 2 plates. Ann des Pontes et Chaussées—3 Trimestre, 1899. No. 32118 E + F.

Turbidity.

Silica Standards for the Determination of Turbidity in Water. George C. Whipple and Daniel D. Jackson. Explains the silica method and commends it for its simplicity, uniformity, and accuracy. 1200 w. Tech Quar—Dec., 1899. No. 31844 E.

Waste.

Water Waste. Joseph C. Beardsley. Advocating the use of meters to prevent waste, and giving the experience of Cleveland, O. 3500 w. Jour Assn of Engng Socs—Dec., 1899. No. 32018 C.

Water Power.

The Law of Water and Modern Industry (La Ley de Aguas y las Industrias Modernas). J. Nolla y Ailu. An argument that the increasing use of water power for generating electricity requires a reformation of the law of June 13, 1879, referring to water powers. 3000 w. Revista de Obras Publicas—Dec. 21, 1899. No. 32187 D.

Water Supply.

Melbourne Water Supply. The history of the supply, describing the sources, and the improvements carried out. Ill. 3300 w. Engng—Jan. 5, 1900. No. 31923 A.

The New Croton Dam—New York City's Water Supply. Brief illustrated description of an engineering undertaking which will greatly change the appearance of the Croton valley. 1200 w. Sci Am—Jan. 20, 1900. No. 31956.

The Water Supply of Large Cities. An editorial on the probable return to large streams and ponds as sources of municipal supply, in consequence of the reduced pollution which courts will allow, and of improvements in filtration processes. 900 w. Eng Rec—Jan. 27, 1900. No. 32087.

Waterway.

The Waterway Between Cosel and Breslau (Der Wasserweg zwischen Cosel und Breslau). Jos. Riedel. With diagrams showing the mean height of the Oder at various points; also sections of the river bed and a description of the navigation of the upper Oder. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 15, 1899. No. 32114 B.

Water-Works.

The Dresden Water-Works. James H. Fuertes. Illustrated description of some of the largest ground-water works now in service. 10000 w. Eng Rec—Dec. 30, 1899. No. 31670.

The Water-Works of Portland, England. Illustrated description of works drawing a supply from a well with headings run out from it; the covered reservoir is of unusual design on account of its combination of a circular ground plan with barrel-arch roof. 2000 w. Eng Rec—Jan. 13, 1900. No. 31884.

Windmills.

The Homemade Windmills of Nebraska. Erwin Hinckley Barbour. Condensed from Bul. of U. S. Agri. Ex. Station of Neb. The first of a series of illustrated articles showing the invention of Nebaska farmers for furnishing a cheap means of irrigation. 4000 w. Sci Am Sup—Jan. 13, 1899. Serial. 1st part. No. 31847.

MATERIALS.

Beams.

Supports for Beams in Tests of Transverse Strength. William T. Magruder. Presented at meeting of the Am. Assn. for the Adv. of Science. Illustrated description of tests made at the Ohio State Univ. 900 w. Eng News—Jan. 11, 1900. No. 31863.

Cement.

Comparative Tests of Different Forms of Cement Briquettes. Illustrated review of experiments made by H. C. Belcher and Jerome Sondericker fixing certain features of testing apparatus as necessary to obtain comparable results. 2700 w. Eng Rec—Dec. 30, 1899. No. 31669.

Tests of the Constancy of Volume of Portland Cement. A review of the report of the Society of German Portland Cement Manufacturers and the Mechanical Testing Laboratory of the Berlin Technical School on the value of accelerated tests for soundness. 3300 w. Eng Rec—Jan. 20, 1900. Serial. 1st part. No. 31991.

Stresses.

Stresses in Circular Plates. Edward Godfrey. A letter discussing this subject and aiming to show that some of the formulas in use are wrong. 1800 w. Eng News—Jan. 4, 1900. No. 31745.

Timbers.

Physical Tests of Some Pacific Coast Timbers. Frank Soulé. Reports tests of Douglas spruce and California redwood. 1200 w. Trans Am Inst of Min Engs—Sept., 1899. No. 31653 D.

MEASUREMENT.

Surveying.

Hints Upon Transit Surveys, and the Avoidance and Checking of Errors. E. Sherman Gould. Recomends methods tested by practical experience for the avoidance of errors in instrumental work. 3000 w. Eng News—Jan. 4, 1900. No. 31741.

The Rectangular System of United States Public Land Surveying. Charles L. Du Bois. An exposition of the system used, rates, methods, etc. Ill. 6000 w. Tech Quar—Dec., 1899. No. 31-843 E.

MUNICIPAL.

Asphalt Pavement.

Failures in Asphalt Pavements. A paper by A. W. Dow on the different influences which will cause the premature destruction of such pavements, and the remedies. 4000 w. Eng Rec—Jan. 6, 1900. No. 31766.

Fire Protection.

Fire Protection. Francis B. Stevens. An account of fires dating back to 1845, illustrating the progress made in means of extinguishing fires, discussing also systems for pumping salt water. 2500 w. Stevens Ind—Jan., 1900. No. 32-248 D.

Garbage Fuel.

The Utilization of Garbage for Fuel. From the *N. Y. Times*. Letters on this subject by George Westinghouse, R. H. Thurston, and Cary T. Hutchinson. 2200 w. Eng Rec—Jan. 20, 1900. No. 31992.

Power Station.

Municipal Lighting and Sewerage Plant, Concord, Mass. Illustrated detailed description of a small plant as nearly as possible automatic in its operation. 1300 w. Elec Wld & Engr—Jan. 13, 1900. No. 31906.

Refuse.

Refuse and Its Calorific Power. Ed. C. de Segundo. Remarks on investigations made which are considered inadequate for furnishing reliable data. 1700 w. Elec Rev, Lond—Jan. 12, 1900. No. 32030 A.

Sewage.

New Sewage Farm for the St. Denis Ward of Montreal. Illustrated description of a farm of 20.05 acres, which it is expected will care for the sewage of 12,000 people. 800 w. Eng News—Jan. 25, 1900. No. 32072.

Sewage Disposal at Alliance, O. Describes the operation of a plant using chemical treatment and gives the resulting purification attained. 1800 w. Eng Rec—Jan. 13, 1900. No. 31883.

The Problem of Sewage Sludge Disposal. W. L. Hedenberg. Discusses the four general methods of sludge disposal, and their advantages and objections. 3000 w. Munic Engng—Jan., 1900. No. 31700 C.

The Sewerage of Edinburgh, Scotland. James H. Fuertes. Illustrates and describes the novel details of the works and of the method of irrigating with the sewage. 1000 w. Eng Rec—Jan. 13, 1900. No. 31882.

Sewers.

A New Sewer Invert Block. Illustrated description of the block designed by A. N. Talbot to concentrate the minimum flow in a sewer in a channel of small radius. 900 w. Eng Rec—Jan. 6, 1900. No. 31765.

Maintenance of Sewers. Elmer D. Fletcher. Letter giving methods of cleaning by floats, employed at Winchester, Mass. 700 w. Eng Rec—Jan. 27, 1900. No. 32093.

Siam.

Public Improvements in Siam. Concerning the electric light and the streets of Bangkok. 1100 w. U. S. Cons Repts, No. 636—Jan. 24, 1900. No. 32044 D.

Tunnel.

On With the Tunnel. Letter to the editor discussing the problem of more closely uniting the various districts of Greater New York. 1800 w. R R Gaz —Jan. 19, 1900. No. 31977.

MISCELLANY.

Africa.

The Economic Conquest of Africa. H. G. Prout. A forecast of the economic future of Africa, showing the changes which may be expected from the introduction of European methods of exploitation, transport and development. 4000 w. Engineering Magazine—Feb., 1900. No. 32190 B.

Review.

Engineering Review of 1899. Editorial review of all branches of engineering, noting the most prominent feaures, and giving much interesting information. 28500 w. Engr, Lond—Jan. 5, 1900. No. 31921 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

An American Pacific Cable. George Owen Squier. Discusses the urgent need of this cable, the routes, practicability, cost, maintenance, operation, etc., giving maps. 7500 w. Trans Am Inst of Elec Engs—Nov., 1899. No. 31955 D.

Breaks in Submarine Cables Close to Repairs. Andrew Gray. Read before the Inst. of Civ. Engs. Considers that, in general, excessive dragging of old cable is the principal cause. 1000 w. Prac Engr—Jan. 12, 1900. No. 32022 A.

India-Rubber as Insulating Material for Cables. Oscar Schaefer. Information on the manufacture of india cores, land cables, and wires, etc. 1300 w. Elect'n, Lond—Jan. 19, 1900. No. 32-225 A.

The Breaking of Cables (Ueber Kabeldurchschlage). Gisbert Kapp. A general review of the causes of break-downs in cables, showing these to be mainly due to the connecting and disconnecting of the conductors in the wrong order; or to the earth contact of the inside conductor, the discussion referring to concentric cables. 6000 w. Elektrotech Zeitschr—Dec. 28, 1899. No. 32166 B.

Transpacific Telegraphy: An Alternative Route. F. R. G. S. Describes a route north through British Columbia and Alaska to Behring Straits, and connecting with a line to Siberia, discussing the commercial aspect and physical difficulties, and comparing costs. 1200 w. Elec Wld & Engr—Jan. 20, 1900. No. 32007.

Exchange.

The "Bedford" Telephone Exchange, Brooklyn. Illustrated description. 500 w. Elec Wld & Engr—Jan. 20, 1900. No. 32008.

The "Central Energy," Multiple Switchboard Independent Telephone Exchange, Parkersburg, W. Va. Illustrated description of the installation of one of the most modern and complete systems. 700 w. Elec Wld & Engr—Jan. 27, 1900. No. 32097.

The Kinloch Telephone Exchange, of St. Louis, Mo. Illustrated detailed description. Two articles, by Frederick E. Bausch and Frank Clark Cosby, describing the exchange and its operation, and the terminal system and underground and aerial lines. Fully illustrated. 6800 w. Elec Wld & Engr—Jan. 6, 1900. No. 31792.

Mont Blanc.

The Work on Mont Blanc in 1899 (Note sur les Travaux au Mont Blanc en 1899). A communication, by Prof. Janssen to the French Academy describing the successful use of uncovered wires laid directly on the ice for the telegraphic communication. 1200 w. Comptes Rendus—Dec. 11, 1899. No. 32123 D.

Overhead Wires.

The Mechanical Stresses on Overhead Electric Wires (Ueber die Mechanische Beauspruchung Elektrischer Luftleitungen). Max Jüllig. Discussing especially the case in which the poles are of unequal height, and showing by a mathematical examination of the catenary, that the greatest stress is at the highest point of attachment. 4000 w. Elektrotech Zeitschr—Dec. 21, 1899. No. 32165 B.

Space Telegraphy.

Recent Patents for Telegraphing Without Wires (Neue Patente für das Telegraphiren ohne Draht). Especially discussing the later patents of Marconi in regard to the use of transformers and condensers. 2000 w. Elektrotech Zeitschr—Jan. 4, 1900. No. 32169 B.

The Development of Wireless Telegraphy. Patrick B. Delany. A historical review of the developments and discoveries which led up to the practical applications of Marconi, showing the present methods of operation and possible future advances. 3500 w. Engineering Magazine—February, 1900. No. 32197 B.

The History and Present Development of Wireless Telegraphy. Greenleaf W. Pickard. Read at meeting of the Maine Academy of Medicine and Science. 5000 w. Sci Am Sup—Jan. 13, 1900. No. 31846.

Switchboard.

Telephone Switchboard with Levers for Metallic Circuits (Tableau Téléphonique à Leviers pour Lignes Doubles). L. Motillot. Illustrating the Fournaire system, in which lever switches are used instead of the customary jacks. 1200 w. L'Electricien—Jan. 13, 1900. No. 32-180 B.

Telegraphy.

Present Day Telegraphy. J. Wright. Notes the various systems in use, and describes the Wheatstone Automatic system. 4200 w. Ind & East Engr—Dec., 1899. No. 31970 D.

Telephone Currents.

The Energy of Telephone Currents. Eugene W. Caldwell. Illustrates and describes experiments made to determine under what conditions a transmitter would give the best results and also to measure the energy. 1700 w. Elec Rev, N. Y.—Jan. 3, 1900. No. 31841 C.

Telephones.

Independent Telephone Development of 1899. H. D. Critchfield. Reports unprecedented progress. 1300 w. W Elect'n —Jan. 6, 1900. No. 31806.

Some Interesting Faults on Telephone Circuits. Describes some interesting faults due to storms, electric light or power circuits, faulty construction and ordinary wear and tear. Ill. 1400 w. Elec Rev, Lond—Jan. 19, 1900. No. 32-230 A.

The Dardeau Telephone System (Le Système Téléphonique Dardeau). A special system for use in connection with railway signalling, for multiple circuits, the telephone replacing the Morse telegraph instruments. Two articles. 2000 w. L'Electricien—Dec. 23, 30, 1899. No. 32179 each B.

The Telephone in Sweden. A short account of how the universal use of the telephone has been brought about, and the high degree of development. 1500 w. Engng—Dec. 29, 1899. No. 31832 A.

DISTRIBUTION.

Alternating Currents.

Compensation of Line Drop in Alternating Current Circuits. E. J. Berg. An elucidation of this subject, illustrated by example. 2200 w. Elec Wld & Engr—Jan. 13, 1900. No. 31908.

Converters.

Rotary Field Converters and Rotary Field Transformers (Drehfeld Umformer und Drehfeld Transformator). J. Herrman. A comparison of the apparatus for converting rotary into continuous currents, and also for converting and at the same time transforming pressure. 2000 w. Elektrotech Zeitschr—Jan. 18, 1900. No. 32174 B.

The Rotary Phase Converter. R. W. Quick. An analysis of the m-to-n phase conversion. 2800 w. Elec Wld & Engr —Jan. 6, 1900. No. 31793.

Insulation.

The Use of Rubber Insulated Wire in Steel Conduits. V. Zingler. Urging either another form of insulation, or a better grade of rubber, when the wires are drawn into metal tubes. 1800 w. Elec Rev, Lond—Jan. 5, 1900. No. 31-941 A.

Stray Currents.

Destructive Effects of Vagrant Electricity. Hubert S. Wynkoop. An explanation of the decay called electrolysis and suggestions for overcoming the difficulty. Ill. 2000 w. Ap Pop Sci M—Jan., 1900. No. 31659 C.

Three-Wire.

Three-Wire Distribution from One Machine. Edward Bretch. Explanation of the means for connecting the neutral of a three-wire system into the windings of a direct-current generator, the brushes of which are connected to the positive and negative sides of the system. 1100 w. Elec Wld & Engr—Jan. 13, 1900. No. 31907.

ELECTRO-CHEMISTRY.

Chemicals.

A New Electrolytic Process of Manufacturing Chemicals. A description of the Hargreaves-Bird process as explained in the *Liverpool Post*, with comments. 700 w. U. S. Cons Repts, No. 617—Jan. 2, 1900. No. 31662 D.

Contact.

The Contact v. the Chemical Theory of the Volta Effect. Discusses the controversy on the action of the Volta contact effect, giving the views of prominent experimenters. Ill. 4000 w. Elec Rev, Lond—Dec. 29, 1899. No. 31814 A.

Dissociation.

The Application of the Dissociation Theory to the Electrolysis of Aqueous Solutions (Ueber die Verwendbarkeit dei Dissociations-theorie bei Elektrolyse Wässriger Lösungen). J. G. MacGregor. Discussing the particular case in which two electrolytes and a common ion are used, giving tables of results with a number of solutions. 2500 w. Elektrochem Zeitschr—Jan. 1, 1900. No. 32178 D.

Electrolysis.

Apparatus for Use in Experimental Fused Electrolysis. Alec. A. Beadle. Hints gained fom experience. Ill. 800 w. Elec Rev, Lond—Jan. 19, 1900. Serial. 1st part. No. 32228 A.

Equations.

General Equations of Condition (Allgemeine Zustandsgleichung). R. Mewes. A discussion of the fundamental theoretical equations upon which electrochemical and other chemical relations depend. 3000 w. Elektrochemische Zeitschr—Jan. 1, 1900. No. 32177 D.

Hypochlorites.

The Electrolytic Production of Hypochlorites (Zur Kenntnis der Elektrolytischen Herstellung von Hypochloriten). A. Sieverts. A record and discussion of an extensive series of experiments upon the production of hypochlorites by electrolysis of neutral chloride solution, in the laboratory of the Technical High School at Dresden. Two articles, 5000 w. Zeitschr f Elektrochemie—Jan. 4, 11, 1900. No. 32176 each D.

Ions.

The Heat of Formation of Ions. A. Hollard. Translated from the *Revue genérale des Sciences*. Explains method of calculation. 1500 w. Elec Eng, Lond—Jan. 12, 1900. Serial. 1st part. No. 32028 A.

Progress.

Recent Electro-Chemical Progress. C. Knox Harding. Notes on the advances made during 1899. 1200 w. W Elect'n—Jan. 6, 1900. No. 31807.

Review.

The Electro-Chemical and Electro-Metallurgical Industries in 1899. John B. C. Kershaw. A review of progress, some of the industries showing steady advancement, while the calcium carbide industry has been phenomenal in its growth. 2800 w. Elec Rev, Lond—Jan. 5, 1900. Serial. 1st part. No. 31940 A.

Voltaic Cell.

Electrolytic Mechanism of the Voltaic Cell. W. R. Cooper. From a book on "Primary Batteries," soon to be published. Shows the Grotthus hypothesis to be unsatisfactory, and discusses the theories of other investigators in part first. 2200 w. Elect'n, Lond—Jan. 19, 1900. Serial. 1st part. No. 32226 A.

ELECTRO-PHYSICS.

Alternating Currents.

The Symbolic Representation of Double-Vector Products and Alternating Waves in General (Symbolische Darstellung Doppelperiodischer Vektorprodukte und Allgemeiner Wechselstromwellen). C. P. Steinmetz. An elaborate mathematical treatment, giving equations and graphical diagrams as applied to a number of practical cases. Two articles. 7500 w. Elektrotech Zeitschr —Dec. 21, 28, 1899. No. 32163 each B.

Atmospheric Electricity.

The Electrification of the Atmosphere. An account of contributions to this subject made in recent years, and of researches. 3000 w. Engng—Jan. 5, 1900. No. 31922 A.

Hysteresis.

A New Method for Studying Hysteresis Curves in Samples of Iron and Steel. Knut Augström. Abstract translation of paper read before the Konglish Vetenskaps-Akademiens Forhandlingar, in Copenhagen. Describes a method of using cathode rays for experimental research. Ill. 700 w. Elec Rev, N. Y.—Jan. 10, 1900. No. 31900.

Laboratory.

The Powerful Current Plant of the Electro-chemical Laboratory of the Zurich Polytechnic (Die Starkstromanlage im Elektrochemischen Laboratorium des Eidgen. Polytechnikums in Zurich). R. Lorenz. Giving view and plan of the special building, together with illustrations and description of this special laboratory department. 3000 w. Zeitschr f Elektrochemie—Jan. 4, 1900. No. 32175 D.

Magnetism.

The Influence of Heating Upon the Magnetic Properties of Low Steel Plates (Der Einfluss des Ausglühens auf die Magnetischen Eigenschaften von Flusseisenbleche). Hans Kamps. A detailed account of the results of tests, with tables and graphical diagrams, devoting especial attention to the effects of red heat upon hysteresis and remanence. Two articles, 5000 w. Stahl und Eisen—Dec. 1. 15. 1899. No. 32144 each D.

Phase Differences.

Means of Attaining Larger Phase Differences, and Their Application to Various Measuring Instruments. Johannes Görner. From the *Elektrotechnische Zeitschrift.* Describes arrangements adopted by Hartmann and Braun, of Frankfort a/M. for the construction of instruments in which such displacements of currents or fields are necessary. Ill. 1200 w. Elect'n, Lond—Dec. 22, 1899. No. 31716 A.

Method of Detecting and Equalizing the Period Difference of the Alternating Circuits (Anordnunegn zur Erkennung und Ausgleichung der Periodendifferenz Zweier Wechselstromkreise). W. Ritter, Giving a number of diagrams showing methods of connecting alternators when operated in parallel. 3500 w. Elektrotech Zeitschr—Jan. 4, 1900. No. 32168 B.

The Compounding of Harmonic Vibrations with Fixed Phase Differences. William Hallock. An account of experiments with telephones. 700 w. Elec Rev, N. Y.—Jan. 3, 1900. No. 31840 C.

Radiography.

The Use of Three-Phase Currents in Radiography (De l'Emploi des Courants Triphasés en Radiographie). M. Delézinier. A communication to the French Academy describing the successful use of three-phase currents in connection with the Wehnelt interrupter, for making radiographs. 800 w. Comptes Rendus—Dec. 26, 1899. No. 32124 D.

Resistance.

Variation of Resistance Under Mechanical Pressure. Lawrence Birks. Discusses the results of experiments made by Prof. S. Lussana. 700 w. Elect'n, Lond—Jan. 12, 1900. No. 32026 A.

GENERATING STATIONS.

Bolton Works.

Bolton Corporation Electricity Works. Illustrated description of plant for supplying power to tramways and to the direct-current lighting mains. 2300 w. Elec Rev, Lond—Jan. 19, 1900. No. 32229 A.

Cambridge, Eng.

Cambridge Electricity Supply Works. Illustrates and describes the work of supplying current for lighting and power in this English university town. 4000 w. Elec Eng, Lond—Jan. 12, 1900. No. 32027 A.

Chambly.

The Chambly Transmission Plant. E. M. Archibald. An illustrated description of the electrical equipment of the plant. 3000 w. Can Elec News—Jan., 1900. No. 31899.

Costs.

Electricity Supply Works Costs in 1897 and 1898. Tables and useful information. 4000 w. Elect'n, Lond—Jan. 5, 1900. No. 31934 A.

Dynamos.

Recent Papers on the Commutation of the Direct-Current Dynamos. An account of the work done and papers published bearing on this problem. Ill. 2500 w. Elec Rev, Lond—Jan. 12, 1900. Serial. 1st part. No. 32031 A.

The Determination of Defects in Dynamos (Beiträge zur Fehlerbestimmung in Dynamo-maschinen). Karl Richter. A review of Frölich's method, showing the use of the Wheatstone bridge in detecting and locating defects in electric generators. 6000 w. Elektrotech Zeitschr—Jan. 11, 1900. No. 32172 B.

Garbage Fuel.

See Civil Engineering, Municipal.

Generators.

Electrical Supply and Alternator Design. Alton D. Adams. Advocates the use of double-current generators to meet the requirements of urban and suburban central-station loads. 2000 w. Elec Wld & Engr—Jan. 27, 1900. No. 32098.

The Factors Which Determine the Design of Monophase and Polyphase Generators. B. A. Behrend. Results of the writer's investigations are given, the present article dealing with the factors which are necessary to predetermine the static characteristic of the alternator. 2000 w. Elec Wld & Engr—Jan. 20, 1900. Serial. 1st part. No. 32004.

Kalamazoo, Mich.

The Kalamazoo Valley Electric Company's Plant. W. G. Fargo and J. B. Foote. Illustrated description of the framed dam, generating station and transmission lines of a plant of 2,000 H. P., serving a district 46 miles long. 2200 w. Eng Rec—Jan. 13, 1900. No. 31880.

Lighting Station.

A Typical Modern Electric Lighting Central Station. Illustrated description of the new high-tension generating plant of the Philadelphia Electric Company. 2800 w. Elec Rev, N. Y.—Jan. 24, 1900. No. 32084.

Petoskey's Lighting Plant. Illustrated description. 1500 w. W Elect'n—Jan. 13, 1900. No. 31950.

Milan.

The Milan Electric Power and Lighting Works. Illustrated description translated from the *Zeitschrift des Vereines Deutscher Ingenieure.* 1300 w. Engr, Lond—Dec. 22, 1899. No. 31730 A.

Niagara.

The Development and Extensions of the Niagara Power System Up to Date. J. E. Woodbridge. Illustrations and information on the most advanced developments of polyphase work. 13000 w. Am Elect'n—Jan., 1900. No. 31796.

The Niagara Falls Hydraulic Power & Manufacturing Company's Plant. Illustrated description of a plant in which the water is received through large penstocks running down the face of Niagara Gorge; the last of these penstocks is 200 ft. high, 11 ft. in diameter and entirely free from supports between its top and bottom. 3000 w. Eng Rec—Jan. 20, 1900. No. 31987.

Parallel Operation.

Parallel Operation of Direct-Coupled Alternators. W. L. R. Emmet. An explanation of a principle of importance in the proper parallel operation of engine-driven alternators. 1200 w. Elec Wld & Engr—Jan. 20, 1900. No. 32005.

Power Stations.

See Civil Engineering, Municipal.
See Street and Electric Tramways.

Review.

Progress of Central-Station Work. Homer E. Niesz. A review of the last year, commenting on the improvements made. 2500 w. W Elect'n—Jan. 6, 1900. No. 31804.

Storage Batteries.

Storage Batteries and Isolated Plants. Alton D. Adams. Discusses the advantages to building owners where electric power is required, by the use of a storage battery. 2800 w. Elec Wld & Engr—Dec. 30, 1899. No. 31684.

Swiss Practice.

Switzerland. An illustrated description of the supply station at Schaffhausen. 1700 w. Elec Eng, Lond—Jan. 5, 1900. No. 31946 A.

Transformers.

A Graphical Treatment of the Effect of Magnetic Leakage on Transformer Regulation. F. G. Baum. Description of method. 1200 w. Elec Wld & Engr—Jan. 13, 1900. No. 31909.

A New Type of Transformer. Illustrates and describes a new type of transformer constructed by the Helios Co., of Cologne, as given in an article by C. P. Feldmann. 700 w. Elec Engr, Lond—Dec. 29, 1899. No. 31813 A.

University Plant.

Electrical Plant of Ohio State University. Burcham Harding. Illustrated detailed description. 1500 w. Elec Wld & Engr—Dec. 30, 1899. No. 31683.

LIGHTING.

Arc Lighting.

Cost of Arc Lighting. H. H. Wait. A communication in discussion of a paper by William Lispenard Robb, on Series Arc Lighting from Constant Current Transformers. 4700 w. Trans Am Inst of Elec Engs—Nov., 1899. No. 31954 D.

Modern Development in Alternating-Circuit Series Arc Lamps. R. Fleming. Read at Milwaukee meeting of the Northwestern Elec. Ass'n. Part first reviews the slow development of arc lighting by means of alternating currents. 1000 w. Elec Rev, N. Y.—Jan. 24, 1900. Serial. 1st part. No. 32085.

Series Arc Lighting from Constant Current Transformers. William Lispenard Robb. A record of the data obtained in the operation of these transformers. Also discussion. 7200 w. Trans Am Inst of Elec Engs—Nov., 1899. No. 31953 D.

The Development of Constant Current Arc Lighting. H. M. Biebel. Read before the Chicago Elec. Assn. Treats of the generators used, and other related subjects. 2700 w. Elec Rev, N. Y.—Jan. 17, 1900. No. 31981.

The Scientific Principles of Public Lighting by Arc Lamps. F. W. Carter. A study of the principles and a discussion of the problem of finding a system of lights to satisfy stated conditions. 1800 w. Elec Rev, Lond—Dec. 22, 1899. Serial. 1st part. No. 31718 A.

Car Lighting.

See Railway Affairs, Equipment.

Electric Light.

Cheap Electric-Light from Gas. Alton D. Adams. Some facts regarding the gas-engine and dynamo plant. 1600 w. Am Arch—Jan. 20, 1900. No. 31984.

Engines.

See Mechanical Engineering, Steam Engineering.

Isolated Plants.

The Electric Lighting of an Hotel. Illustrates and describes an interesting plant in England. 900 w. Elec Rev, Lond—Dec. 29, 1899. No. 31817 A.

Nernst Lamp.

Possibilities of the Nernst Lamp. Frank H. Mason. Brief statement of the advantages and disadvantages. 1200 w. Gas Wld—Jan. 6, 1900. No. 31913 A.

Post-Office.

Lighting and Power Installation of the New Post-Office Department Building, Washington, D. C. J. P. Alexander. Brief illustrated description of an extensive installation. 1100 w. Elec Wld & Engr—Jan. 6, 1900. No. 31794.

Trieste.

Electric Lighting Plant and Street Lamps of Trieste, Austria. Josef Herzog. Brief illustrated description. 400 w. Elec Wld & Engr—Jan. 6, 1900. No. 31795.

MEASUREMENT.

Hysteresis.

The Testing of Hysteresis in Armature Cores. Francis G. Baily. An account of experiments made and results obtained. 1500 w. Elect'n, Lond—Dec. 29, 1899. No. 31820 A.

Indicators.

Notes on Maximum Demand Indicators. Louis J. Steele. Illustrated description of the Halsey maximum demand indicator, stating its advantages. 2500 w. Elec Rev, Lond—Jan. 5, 1900. No. 31936 A.

Resistance.

A Note on the Electrical Resistivity of Electrolytic Nickel. J. A. Fleming. Read before the Royal Society. Reports the result of researches. 1200 w. Elec Rev, Lond—Jan. 5, 1900. No. 31938 A.

Speed Indicator.

Stroboscopic Methods of Determining the Revolutions and Slip of Small Motors, and the Frequency of Alternating Currents. Illustrates and describes methods devised by Dr. G. Benischke, and the apparatus used. 1200 w. Elec Rev, Lond—Jan. 5, 1900. No. 31935 A.

Units.

Our Electric Units; What Shall We Do With Them? J. A. Fleming. Discussion of the advisability of a revision of the system, and suggesting a rational system that the writer considers practical and sound. 2200 w. Elect'n, Lond—Dec. 29, 1899. Serial. 1st part. No. 31821 A.

TRANSMISSION.

Alternate Currents.

Alternate-Current Power Transmissions. C. Du Riche Preller. Considers the distribution of energy and the practical working results as shown in three installations transmitting energy over large areas. Ill. 2000 w. Engng—Jan. 12, 1900. No. 32032 A.

Long-Distance.

San Gabriel Electric Company. An illustrated description of an interesting plant transmitting electric current to Los Angeles, Cal. 2200 w. Engng—Dec. 22, 1899. Serial. 1st part. No. 31722 A.

Protection.

On the Protection of Electric Power Transmissions from Lightning. J. T. Morris. Miller prize paper read at students' meeting of the Inst. of Civ. Engs. Part first gives illustrated descriptions of lightning arresters. 2000 w. Elec Rev, Lond—Jan. 5, 1900. Serial. 1st part. No. 31939 A.

Quarry.

An Electrical Quarry Installation. Illustrated description of an electrical transmission plant for working a quarry in a mountainous district in the Lowlands of Scotland. 700 w. Elec Rev, Lond—Dec. 22, 1899. No. 31719 A.

POWER APPLICATIONS.

Accumulators.

The International Competition of Accumulators (Concours International d'Accumulateurs). The official report of the tests of storage batteries adapted for automobiles as conducted by the Automobile Club de France. 3000 w. L'Electricien—Jan. 13, 1900. No. 32181 B.

The International Competition of Accumulators for Automobile Vehicles. (Concours International d'Accumulateurs pour Voitures Automobiles). A summary of the official report, giving results of tests upon eight forms of accumulators. 1000 w. Génie Civil—Jan. 13, 1900. No. 32109 D.

Clocks.

Electrical Time Service. F. Hope

Jones. Read before the Inst. of Elec. Engs., England. An account of the various inventions connected with electric clocks, with an illustrated description of devices of the writer. 4000 w. Elect'n, Lond—Dec. 22, 1899. Serial. 1st part. No. 31717 A.

Cranes.

Electric Traveling Cranes. Illustrated detailed description of cranes manufactured in England. 2500 w. Engng—Jan. 5, 1900. No. 31925 A.

Electric-Power.

See Mining and Metallurgy, Mining.

Hoisting.

Generators, Motors, and Switching Apparatus for Electric Hoisting Machinery (Generatoren, Motoren. und Schaltapparate für Elektrisch Betriebene Hebezeuge). F. Niethammer. A very elaborate discussion of the arrangement of electrical machinery of cranes, elevators, conveyors and similar apparatus. Two articles. 10000 w. Elektrotech Zeitschr—Jan. 11, 18, 1900. No. 32171 each B.

Mining Plant.

The Electric Plant in the Falck Coal Mines at Bockwa, near Cainsdorf, Saxony (Die Elektrische Anlagé auf dem Steinkohlenwerk Karl G. Falck in Bockwa b. Cainsdorf i. s.). Describing an excellent application of electric power in coal mining, the plant having operated uninterruptedly from its start in September, 1898. The pit is 765 feet deep. 1200 w. Glückauf—Dec. 23, 1899. No. 32157 B.

MISCELLANY.

Accidents.

Death by Electricity. R. H. Cunningham. Researches to determine the cause of death. Experiments were made on the lower animals and the results are stated. Also editorial notes. 3800 w. Elec Wld & Engr—Dec. 30, 1899. No. 31682.

The Cause of Death from Electric Lighting Currents. W. S. Hedley. The writer considers that in some instances death is due to arrested respiration and in others to stoppage of heart action. 1500 w. Elec Rev, Lond—Jan. 12, 1900. No. 32029 A.

Aluminum.

Aluminum and Its Uses and Treatment in Electrical Engineering. J. H. Henderson. Abstract of a paper read before the Manchester Junior Electrical Engineers. Considers its extraction, its use as a conductor, and in the workshop. 1200 w. Prac Engr—Dec. 22, 1899. No. 31713 A.

Exposition.

American Exhibits at the Paris Exposition of 1900. Part first gives an account of the Department of Electricity and Transportation, by James S. Anthony; and the Transportation Exhibits, by George S. Wilkins. 3500 w. Ill. St Ry Jour—Jan. 6, 1900. Serial. 1st part. No. 31803 D.

Electrical Preparations for the Paris Exposition. Illustrates and describes the United States Court of Honor for the exhibit of electrical and mechanical apparatus of a pioneer or historical character. 1400 w. Elec Wld & Engr—Jan. 20, 1900. No. 32003.

Museum.

The Electrical Collections in the Smithsonian Institution and the National Museum. George C. Maynard. The first part of this serial is a brief history of the Smithsonian Institution and its organization. Ill. 1800 w. Elec Rev, N. Y.—Jan. 3, 1900. Serial. 1st part. No. 31842 C.

Review.

American Electrical Progress During 1899. Charles T. Child. A year's history of the development of electrical engineering and industry in the United States. 3500 w. Elec Rev, N. Y.—Jan. 3, 1900. No. 31839 C.

Recent Progress in the Electrical Industries. Henry L. Doherty. Abstract of a presidential address delivered at the convention of the Northwestern Elec. Assn., at Milwaukee. 2000 w. Eng News—Jan. 25, 1900. No. 32078.

GAS ENGINEERING

Acetylene.

Acetylene Gas Considered Commercially. Horace Allen. Discusses the possible reduction of cost by the use of blast-furnace gas in the production of calcium carbide. 1300 w. Elec Rev, Lond—Jan. 5, 1900. No. 31937 A.

On the Products of the Explosion of Acetylene. W. G. Mixter. An illustrated account of experiments made to obtain facts for or against the hypothesis that a sufficient frequency of molecular impacts is requisite to secure spread of explosive change throughout a gas. 2200 w. Am Jour of Sci—Jan., 1900. No. 31702 D.

The Explosive Side of Acetylene. Frederick H. M'Gahie. An account of some cases studied to determine the limits to avoid dangerous or uneconomic conditions. 1700 w. Sci Am—Jan. 6, 1900. No. 31737.

Analysis.

Apparatus for the Analysis of Illuminating and Fuel Gases. George E. Thomas in *Jour. Am. Chem. Soc.* Illustrated description. 1200 w. Am Gas Lgt Jour—Jan. 8, 1900. No. 31780.

The Analysis of Gas Coal. Describes a laboratory method given in a paper by J. G. A. Rhodin. 900 w. Gas Wld—Jan. 13, 1900. No. 32024 A.

Automatic Meter.

Gas Supply by Automatic Meter. H. O. Eldridge. Read before the So. Dist. Assn. of Gas Engs. and Mgrs. Discusses the difficulties, troubles and successes of supply by automatic meters. 2300 w. Gas Engs' Mag—Jan. 10, 1900. No. 32221 A.

Carbide.

The Cost of Calcium Carbide. A discussion showing the advance that has taken place in this business and especially considering conditions in England. 4300 w. Engr, Lond—Dec. 22, 1899. No. 31727 A.

The Cost of Producing Carbide by Different Agencies. Abstract translation of a paper by F. Liebetanz, read before the Acetylene Congress at Buda Pesth. Shows the effect of the cost of power on the cost of production. 3000 w. Jour Gas Lgt—Dec. 26, 1899. No. 31812 A.

Conflagrations.

Gas Conflagrations. From the *N. Y. Evening Post.* On the dangers from gas main leakage, the cause of fires, effects on health, etc. 1000 w. Am Arch—Jan. 27, 1900. No. 32208.

Cyanide.

Dr. Bueb's Cyanide Recovery Process. A review of a communication by Dr. Scharrer, published in the *Journal für Gasbeleuchtung*, with arguments showing that Dr. Bueb's process follows very closely the process used at Beckton. 2000 w. Jour Gas Lgt—Jan. 9, 1900. No. 31961 A.

Exposition.

The Proposed Gas Exhibition and Congress of Gas Engineers at the Paris Exhibition. An outline of the arrangements made, with illustration of the gas pavilion. 1400 w. Jour Gas Lgt—Jan. 16, 1900. No. 32056 A.

Gasholders.

Foundations for Metal Tanks. R. J. Milbourne. Discusses the conditions necessary in the provision of foundations. Ill. 2000 w. Jour Gas Lgt—Jan. 2, 1900. No. 31859 A.

Gas Transmission.

Gas for Light, Heat and Power Transmission. Alton D. Adams. On the expanding field of gas utilization. 600 w. Am Arch—Jan. 27, 1900. No. 32207.

Gas Works.

Notes on Building Construction in Small Gas-Works. S. B. Langlands. Read before the North of Ireland Assn. of Gas Mgrs. Suggestions concerning site, arrangement and construction of buildings, etc. 1500 w. Gas Engs' Mag—Jan. 10, 1900. No. 32222 A.

Globes.

A Photometric Comparison of Illuminating Globes. Robert B. Williamson and J. Henry Klinck. Illustrated description of tests made with the object of determining the relative merits of various globes for use with the Welsbach incandescent mantle. 1800 w. Jour Fr Inst—Jan., 1900. No. 31869 D.

Nitrogen.

The Recovery of Nitrogen in Coal Distillation. W. Carrick Anderson, and James Roberts. Extract from a paper read before the Scottish section of the Soc. of Chem. Ind. An account of experimental investigations concerning the way nitrogen distributes itself on heating, and obstacles to be overcome. 6000 w. Gas Wld—Jan. 20, 1900. No. 32227 A.

Photometry.

A French Review of Photometry. Review of the address of M. Vautier, president of the Société Technique de l'Industrie du Gaz en France, dealing with photometry in England, Germany, and France. 2700 w. Jour Gas Lgt—Jan. 9, 1900. No. 31960 A.

Pressure.

An Interesting Account of Changed Pressure Conditions in the Gas Supply of Clinton, Iowa. S. M. Highlands. Describes the raising of the pressure on the entire distributing mains with good results. 900 w. Am Gas Lgt Jour—Jan. 15, 1900. No. 31904.

Prices.

A History of Gas Prices in London. Review of a book by Laurence W. S. Rostron, giving also early history of gas supply in London. 1400 w. Jour Gas Lgt—Jan. 16, 1900. No. 32055 A.

Water-Gas.

Water-Gas Plant of the Peoples Company at Buffalo, N. Y. Illustrated description of modern design and construction. 1500 w. Pro Age—Jan. 1, 1900. No. 31692.

The Dellwik-Fleischer Water Gas Process. Describes this process, and claims great economy of production. Ill. 2500 w. Engng—Jan. 26, 1900. No. 32380 A.

MARINE AND NAVAL ENGINEERING

Armament.

The Armament of Our Latest Warships. Illustrations showing the remarkable changes in navy guns during the last fifteen years, with a table showing the ballistics of the 1899 model. 1700 w. Sci Am—Jan. 20, 1900. No. 31957.

Armour.

Armour Plates (Les Plaques de Blindages). L. Baclé. A most exhaustive treatise on the history and development of armour-plate manufacture in Europe and America, with many illustrations. Two articles, 50,000 w. Bull de la Soc d'Encour—Nov., Dec., 1899. No. 32127 each G.

Tests of Some Recent Krupp Armour Plates (Beschussprohe einger Neueren Kruppschen Panzerplatten). J. Castner. With photographs showing the remarkable resistance of some of the latest specimens of Krupp's hardened nickel-steel plates, tested before the Japanese commissioners. 1200 w. Stahl und Eisen—Dec. 1, 1899. No. 32141 D.

Buoys.

Combined Gas Light and Bell Buoy. Robert M. Dixon. Illustrates and describes a device invented by the writer. 700 w. Stevens Ind—Jan., 1900. No. 32247 D.

Coaling.

The Problem of Coaling Warships at Sea. Spencer Miller. Illustrating very fully the apparatus which has been successfully tested and favorably reported upon by the United States Government, fully solving this much discussed problem. 3000 w. Engineering Magazine—Feb., 1900. No. 32194 B.

Coaling Station.

The First Coaling Station for the United States Navy. Illustrates and describes the plant at New London, Conn., for the storage and protection of coal, and for handling from store to vessel with rapidity. 900 w. Ir Age—Jan. 18, 1900. No. 31965.

Cruisers.

H. M. SS. "Pegasus" and "Pyramus." Illustrated description of these two vessels, belonging to a class of eleven. They are fitted with express or small-tube boilers. Gives results of the official trials and of the boiler trials. 2700 w. Engng—Dec. 22, 1899. No. 31723 A.

Docks.

See Civil Engineering, Construction.

Engines.

See Mech. Engineering. Steam Engng.

Ferry Boats.

Railway Ferry Boats in Denmark (Eisenbahn-Dampffähren in Dänemark). Giving plans and sections of ferry boats with one and two tracks; also description of landing stage for manipulation of trains. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 6, 1900. No. 32113 D.

France.

The French Navy in 1899 (La Marine Française en 1899). A review of the work in progress and laid down in 1899, with a brief notice of the work at the various French yards. 2000 w. Le Yacht—Jan. 6, 1900. No. 32189 B.

Harbor Defence.

The United States Harbor-Defence Vessels. Illustrated description of the Arkansas, one of the four vessels being constructed for the U. S. navy. 1800 w. Engr, Lond—Dec. 29, 1899. No. 31829 A.

Ice Yacht.

A Jib-Headed Mainsail Sloop Ice Yacht. H. Percy Ashley. Illustrates and briefly describes a late design. 300 w. Sci Am Sup—Jan. 6, 1900. No. 31739.

Life Boat.

Twin-Screw Lifeboat for the U. S. Life Saving Service. C. H. McLellan. Describes experiments recently made with a gas engine as motive power with gratifying results. Ill. 1300 w. Marine Engng—Jan., 1900. No. 31810 C.

Life-Saving.

Competition for the Best Life-Saving Device in Cases of Disaster at Sea. The official regulations regarding the competition for the Anthony Pollak $20,000 prize for the life-saving devices. 900 w. Sci Am Sup—Jan. 27, 1900. No. 32049.

Merchant Marine.

Striking Growth of Germany's Merchant Marine. Frank H. Mason. An interesting review of the progress and development. 3700 w. Marine Rev—Jan. 4, 1900. No. 31755.

Naval Mountings.

Elswick Naval Mountings. Illustrations and descriptions of mountings for quick-fire guns dealt with in Sir Andrew Noble's paper before the Inst. of Naval Architects. 1200 w. Engr, Lond—Jan. 19, 1900. Serial. 1st part. No. 32210 A.

Naval Work.

Naval Work in English Shipyards and Engine Factories in 1899. Review of the construction of warships and their equipment. 2700 w. Engr, Lond—Dec. 29, 1899. No. 31830 A.

Navies.

British and Foreign Navies. Editorial discussion of official figures given in a recent Government return, making a comparison. 2100 w. Engng—Jan. 12, 1900. No. 32033 A.

Rapid Fire.

Ballistic Tests of the Krupp 15-Cm. Rapid-Fire Naval Gun (Ballistiche Augaben über Kruppsche 15-cm. Marine Schnelllade-Kanonen). J. Castner. A comparison between the light and heavy 15-cm. guns, with ballistic tables and an example of the target practice. 1200 w. Stahl und Eisen—Dec. 15, 1899. No. 32-146 D.

Resistance.

Resistance of Ships. William A. Fairburn. Replies to questions asked concerning conclusions reached in an article published Nov. 9, 1899, in this paper. 2500 w. Marine Rev—Jan. 11, 1900. No. 31903.

Rolling.

The Means Adopted for Moderating the Rolling of Ships. W. J. Luke. Abstract of paper read before the Inst. of Engrs. and Shipbuilders, in Scotland. Discusses the utility of bilge keels, experiments made, etc., in part first. 2200 w. Engs' Gaz—Jan., 1900. Serial. 1st part. No. 31871 A.

Sailing Vessels.

The Strength of Spars and Rigging of Sailing Vessels. Remarks the interesting mechanical problems dealing with the strength and efficiency of these structures, and discusses the applied forces in the present article. 2000 w. Engr, Lond—Jan. 5, 1900. Serial. 1st part. No. 31-915 A.

Shear.

100-Ton Shear with Adjustable Boom. From *Le Génie Civil.* Describes a crane of peculiar construction in use in a German shipyard. Ill. 500 w. Eng News—Jan. 25, 1900. No. 32077.

Shipbuilding.

Shipbuilding and Marine Engineering in 1899. The first of a series of articles considering the work of the several districts and firms. 2800 w. Engng—Jan. 5, 1900. Serial. 1st part. No. 31927 A.

Shipbuilding and Marine Engineering in 1899. A review of this industry in the United Kingdom, giving interesting information. 3600 w. Engng—Dec. 29, 1899. No. 31833 A.

Shipbuilding in Germany. An article showing Germany to be second to England in ocean transportation. 900 w. U. S. Cons Repts, No. 638—Jan. 26, 1900. No. 32083 D.

Shipbuilding Plant of the Union Iron Works at San Francisco. An illustrated description of the works where the "Oregon" was built. 2300 w. Marine Engng—Jan., 1900. No. 31808 C.

Sound Steamer.

New Sound Flyer. Illustrated description of the Chester W. Chapin, the latest addition to the New Haven Steamboat Company's fleet. 1600 w. Nau Gaz—Jan. 11, 1900. No. 31890.

Speed Trials.

Official Speed Trials of the 30-Knot U. S. Torpedo Boat Dahlgren. Describes the severe trials which were carried out so successfully. Ill. 2200 w. Marine Engng—Jan., 1900. No. 31809 C.

Steamships.

Great Modern Steamships (Die Reisendampfer der Neuzeit). Oswald Flamm. A description of the development of the large steamers of the last ten years, with illustrations of numerous examples of German vessels, both of the navy and the merchant marine. 3000 w. Stahl und Eisen—Dec. 1, 1899. No. 32142 D.

The Cunard Steamer Saxonia. Describes a large cargo carrier which has excellent passenger accommodations, but is not designed for great speed. 1500 w. Engr, Lond—Dec. 22, 1899. No. 31731 A.

Steam Yacht.

The Humber Steam Pilot Yacht "Commander Cowley." Brief description with illustrations. 500 w. Engng—Dec. 29, 1899. No. 31831 A.

Steel Ships.

New Competitive Conditions in Steel Shipbuilding. Waldon Fawcett. Considers the changes that will come with the opening of the St. Lawrence canals, thus giving a water way for moderately deep draft vessels between the Great Lakes and the coast. 2200 w. Ir Age—Jan. 18, 1900. No. 31968.

Turrets.

Modern Turrets. Illustrated description of several types, and recent improvements in construction. 1200 w. Sci Am Sup—Jan. 20, 1900. No. 31958.

U. SS. Hartford.

Reconstruction of Farragut's Flagship, the U. SS. "Hartford." An account of the daring entrance to Mobile Bay, with illustrations of the vessel before and after reconstruction. 1200 w. Sci Am—Jan. 27, 1900. No. 32046.

Warships.

Warship Construction in 1899. An account of vessels launched from the Royal dockyards and from shipbuilding works, steam trials, etc. 3500 w. Engng—Dec. 22, 1899. No. 31726 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

See Electrical Engineering, Power Applications.

Costs.

Operating Costs of Horse and Electric Delivery Wagons in New York City. G. F. Sever and R. A. Fliess. Results of an investigation of comparative expenses as at present instituted by the large department stores in New York. 7500 w. Trans Am Inst of Elec Engs—Nov., 1899. No. 31951 D.

Design.

Design of Automobiles. M. C. Krarup. Discusses the construction and the requirements of the public under the present road and street conditions, offering suggestions. 3500 w. Am Mach—Jan. 4, 1900. No. 31752.

Motor Vehicles. Alex. Craig. Excerpt from a paper read before the Cycle Engs.' Inst., Coventry, Eng. Considers motive power, transmission gear, etc., etc. 3200 w. Automotor—Jan., 1900. No. 32063 A.

The Automobile Movement—Styles of Vehicles Required—Separate Tractors. M. C. Krarup. Discusses the difficulties to be overcome, and the conditions in Europe and the United States. 2300 w. Am Mach—Jan. 25, 1900. No. 32060.

The Automobile Vehicle. Fred. J. Newman. A mechanical description of some of the best American vehicles, discussing the features of different types, and some of the engineering problems. 4000 w. Wis Engr—Jan., 1900. No. 32013 D.

Electric Vehicles.

Electric Automobiles. Elmer A. Sperry. Considers in detail the special features of these vehicles, and their maintenance and operation. Ill. 4400 w. Trans Am Inst of Elec Engs—Nov., 1899. No. 31952 D.

The Manufacture of Electric Automobiles. Illustrated description of methods employed by the Columbia & Electric Vehicle Co., of Hartford, Conn. 3200 w. Elec Wld & Engr—Jan. 13, 1900. No. 31905.

The Mors Carriage. Review of the motor, mechanism and general details of the motor vehicles manufactured by the Société de l'Electricité et Automobiles Mors, Grenelle, France. Ill. 1800 w. Sci Am Sup—Jan. 20, 1900. No. 31959.

Liverpool Traffic.

Heavy Motor Wagons for Liverpool Traffic. Arthur Musker. Read before the Liverpool Engng. Soc. Describes the experience of makers in an effort to make a motor wagon having a tare of 3 tons, to carry loads varying from 5 to 10 tons. 3000 w. Automotor—Jan., 1900. No. 32062 A.

The Liverpool Trials of Motor Vehicles. Summary of the report of the judges who conducted the trials from July 31 to Aug. 2, 1899. Ill. 3800 w. Automotor—Jan., 1900. No. 32061 A.

Local Transit.

The Automobile in Local Transit. Sylvester Baxter. Discusses cab service in large cities, and the motor-omnibus service soon to be installed in some American cities. 2500 w. Auto Mag—Feb., 1900. No. 32205 C.

Motor-Car.

The Gobron and Brillié "Silent" Motor-Car. Illustrated description of the interesting features. 2100 w. Ind & Ir—Dec. 29, 1899. No. 31819 A.

Motor Cycles.

Motor Cycle Racing. Al. Reeves. An illustrated account of the working of these machines and of some of the races in the United States. 1200 w. Auto Mag—Jan., 1900. No. 31690 C.

Motor Horse-Powers.

The Truth About Motor Horse-Powers. Georgia Knap. An explanation of the horse-power of automobile motors, based upon brake tests made and repeated. 3300 w. Auto Mag—Jan., 1900. No. 31691 C.

Motor-Wheel.

Motor-Wheel for Vehicles. Illustrated description of a wheel that may be attached to vehicles and bears much the relation to them that a locomotive does to a train. 500 w. Sci Am—Jan. 6, 1900. No. 31738.

Oil Motor.

Oil Engines and Motor Cars. Anthony G. New. Considers the application of oil engines to motor cars. Part first deals with the car, the engine, and the interaction of car and engine. 4300 w. Engr, Lond—Jan. 5, 1900. Serial. 1st part. No. 31914 A.

Omnibus.

The Purrey Steam Automobile (Automotrice à Vapeur, Système Valentin Purrey). H. Brosselin. A detailed description of the mechanism and operation of the steam omnibus now under practical trial by the Compagnie Général des Omnibus of Paris. 7000 w. 2 plates. Rev Gen des Chemins de Fer—Jan., 1900. No. 32137 G.

Postal Service.

Automobile Postal Service. Perry S. Heath. Illustrations of vehicles used and review of tests made in various cities of the United States and in Europe. 2100 w. Auto Mag—Feb,. 1900. No. 32200 C.

Racing.

Motor Racing. Edwin Emerson, Jr. An interesting illustrated account of vehicles and races, discussing the factor of speed, and the proposed races to be run during the Paris Exposition. 3000 w. Auto Mag—Feb., 1900. No. 32201 C.

Official Time-Keeping Rules. Considers methods and instruments employed, and sources of error. 2500 w. Auto Mag—Feb., 1900. No. 32203 C.

The French Racing Rules. Translation of the racing rules drawn up by the French Automobile Club. 4700 w. Auto Mag—Feb., 1900. No. 32202 C.

Review.

One Year's Progress of Automobilism. Félicien Michotte. A review of the advances made during the year in France. Ill. 1800 w. Auto Mag—Feb., 1900. No. 32204 C.

Steam Carriage.

The "Locomobile" Steam Carriage. Illustrated description of the vehicle, its machinery, and operation. 2000 w. Sci Am—Jan. 27, 1900. No. 32047.

Steam Wagons.

A Short Account of Some Modern Steam Wagons. George A. Burls. Part first discusses the tare limit, power, etc. 2200 w. Prac Engr—Jan. 12, 1900. Serial. 1st part. No. 32021 A.

The Simpson-Bodman Steam Lorry. Illustrated detailed description of a vehicle for transporting heavy goods. 2500 w. Ind & Ir—Jan. 19, 1900. No. 32217 A.

Traction.

The Automobile in Traction. Robert H. Thurston. Reviews the past history and present progress, considering the outlook most promising. Ill. 3500 w. Auto Mag—Jan., 1900. No. 31688 C.

Vehicle Motors.

Motor Vehicles and Their Motors (Die Motorwagen und ihre Motoren). A general review of the motors best adapted for automobile service. The first portion is devoted to electric motors. Serial. Part 1. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 6, 1900. No. 32112 D.

Vehicles.

Horse and Automobile Vehicles for Tramways (Les Voitures Tramways à Chevaux et les Voitures Automotrices). G. Manclère. A detailed description, with drawings, of the present standard horse tramway cars of Paris, and of the Serpollet steam tramway vehicle. 7500 w. 4 plates. Rev Gen des Chemins de Fer—Nov., 1899. No. 32131 G.

Weight.

The Tare Weight of Motor Vehicles. H. Wilcke. Letter to the editor reviewing the leading points connected with this matter from an English point of view. 2200 w. Engng—Jan. 12, 1900. No. 32034 A.

HYDRAULICS.

Laboratory.

See Civil Engineering, Hydraulics.

Mine Water.

The Utilization of Mine Water at Hallstatt (Die Verwerthung der Grubenwässer in Hallstatt). C. Schraml. An account of the manner in which the water from the salt mines is used to supplement the local streams in the dry season in connection with the hydraulic power plant. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 6, 1900. No. 32162 B.

Pumping Engines.

Examples of Pumping Engine Construction (Beispiele aus dem Gebiete des Pump-maschinenbaues). Th. v. Bavier. Illustrating and describing a number of pumping engines of recent construction for use in German cities and mines, giving especial attention to those with mechanically actuated pump-valves. 4000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Jan. 6, 1900. No. 32111 D.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

Modern Apprenticeship Conditions. John E. Sweet. From an address before the manufacturers and mechanics of Rochester, N. Y. Considers the training of the schools and of the shops, and the duties of employers and employees. 4500 w. Ir Trd Rev—Jan. 18, 1900. No. 31982.

Boiler Shop.

See Architectural Engineering, Heating.

Bushing.

Bushing a Locomotive Cylinder. General description of the work, with illustrations. 1500 w. Mach, N. Y.—Feb., 1900. No. 32253.

Compensation Act.

The Definition of a "Factory" and the Workmen's Compensation Act. Shows how the absence of a definition for the word factory has given rise to many difficulties since this act first became law. 2700 w. Engr, Lond—Dec. 29, 1899. No. 31827 A.

Compressors.

Compound or Two-Stage Air Compressors. Robert Peele. On the advantages of stage compression, and the rise and construction of the intercooler 2600

w. Mines & Min—Jan., 1900. No. 31857 C.

The Air Compressor. O. G. Smith. A brief statement of the important features in the process of compressing air, and how it is accomplished in the design of air compressors. 1400 w. Ir & Coal Trds Rev—Dec. 22, 1899. No. 31721 A.

Cranes.

See Electrical Engineering, Power Applications.

Designing.

Economy in Design—Employment of Gravity. W. H. Booth. Calls attention to the advantages secured by utilizing the law of gravity. 1500 w. Am Mach—Jan. 25, 1900. No. 32058.

Drafting-Room.

A Model Drafting Room. Illustrates and describes a convenient arrangement with novel features. 1500 w. Mach, N. Y.—Jan., 1900. No. 31687.

A Modern Drafting Room. Illustrated description of a room in which the heating, lighting and ventilation are special features. 1200 w. Mach, N. Y.—Feb., 1900. No. 32249.

The New Drawing Office of the Schenectady Locomotive Works. Illustrated description of an office representing the best facilities. 1500 w. Am Mach—Jan. 18, 1900. No. 31963.

Drilling.

A Duplex Drill Jig for a Multiple Spindle Driller. D. E. MacCarthy. Illustrated description of a tool recently designed by the writer. 400 w. Am Mach—Jan. 11, 1900. No. 31861.

Drill.

4½-Foot Semi-Universal Radial Drill. Illustrated description of a machine intended for drilling and boring. 300 w. Am Mach—Jan. 4, 1900. No. 31751.

Emery Wheel.

The Plant of the Norton Emery Wheel Company. An illustrated account of these works and things seen there. 1600 w. Am Mach—Jan. 25, 1900. No. 32059.

Enameling.

Enameling Cast Iron. J. Vollkommer. Part first considers the nature of enamels, the preliminary preparations, cleaning and pickling, slush or first coat, and fusing. 2300 w. Met Work—Jan. 13, 1900. Serial. 1st part. No. 31877.

Engine Works.

The New Works of the Harrisburg Foundry and Machine Works. Illustrated description of a plant designed to allow all branches of an engine-building industry to be carried out in a single building as far as possible. The arrangements to meet this aim, and the progress of the work from department to department, are explained in detail. 2500 w. Eng Rec—Jan. 27, 1900. No. 32088.

Fitting.

Lining of Shoes and Wedges. W. D. Chamberlin. An illustrated article giving details of a method for this work. 2500 w. Loc Engng—Feb., 1900. No. 32241 C.

Gears.

Some Points About Cutting Spiral Gears—A Special Spiral Gear Cutting Machine. A. L. de Leeuw. Briefly considers methods of cutting, and related subjects, and gives an illustrated description of a machine built at the Niles Tool Works. 3500 w. Am Mach—Jan. 11, 1900. No. 31862.

Guns.

Guns of Position and Siege Guns for the War. Illustrated description of two 4.7-in. quick-firing guns, and remarks on the conditions in South Africa. 1000 w. Engr, Lond—Jan. 5, 1900. No. 31918 A.

Hoisting.

See Electrical Engineering, Power Applications.

Joints.

Shrink and Press Fits. Henry Hess. Discussion from both theoretical and practical standpoints. 2200 w. Mach, N. Y.—Jan., 1900. No. 31686.

Piece Work.

Piece Work and Premium Plan. R. T. Shea. Opposed to the premium plan, and favoring piece work. Also editorial. 2500 w. Loc Engng—Jan., 1900. No. 31677 C.

Premium System.

Actual Experience with the Premium Plan. H. M. Norris. Mr. Norris's concluding paper discloses the attitude and policy of American organized labor as opposed to the introduction of any competitive wage system, whereby the return to the workman is based upon his individual effort. 3500 w. Engineering Magazine—Feb., 1900. No. 32192 B.

Screw Machines.

A Lag-Screw Cutting Machine. An illustrated description of an interesting machine designed for cutting screw-threads upon lag-screws. 1200 w. Am Mach—Jan. 25, 1900. No. 32057.

Multiple Spindle Automatic Screw Machine. Illustrates and describes the Acme machine and the work produced. 2000 w. Am Mach—Jan. 18, 1900. No. 31962.

Screw Threads.

Metric Screw Threads. Henry Harrison Suplee. Statements showing that it is not necessary to equip American lathes with metric lead screws, nor to attempt to produce standard metric dies and taps. 600 w. Mach, N. Y.—Feb., 1900 No. 32251.

Screw Pitches in Foreign Countries. Data upon the pitches of screws used abroad and the gearing for cutting them. 1600 w. Mach, N. Y.—Feb., 1900. No. 32250.

The Standardization of Screw Threads. A summary of information presented in a paper by Signor A. Galassini, and supplemented by facts from other sources. 2800 w. Engng—Jan. 19, 1900. Serial. 1st part. No. 32214 A.

Shop Practice.

Novel Examples of Drill Feeds and Epicyclic Gearing. Illustrated description. 1700 w. Mach, N. Y.—Feb., 1900. No. 32252.

Some Interesting Notes Taken in the Shops of the Arthur Company, New York. Illustrated description of interesting tools and appliances, and of model work. 2000 w. Mach, N. Y.—Jan., 1900. No. 31685.

The Most Perfect Machine Shop. S. D. V. Burr. Illustrated detailed description of Building No. 16 of the Schenectady Works of the General Electric Co. 4000 w. Ir Age—Jan. 4, 1900. No. 31-746.

The Revolution in Machine-Shop Practice. Henry Roland. A discussion of the application of automatic mechanical production to heavy work, especially in respect to the elimination of skilled labor in adjustments and accuracy of relative position of parts. 4000 w. Engineering Magazine—Feb., 1900. No. 32196 B.

Tools.

A Portable Drilling Tool with Suction Support. E. P Buffet. From *Génie Civil.* Illustrated description of a portable drill for use in shipyards, invented by M. L. Moissenet. 800 w. Am Mach—Jan. 18, 1900. No. 31964.

A Tap-Threading Lathe, Threading Tool and a Grooving Fixture. Illustrated description of tools. 1000 w. Am Mach—Jan. 4, 1900. No. 31753.

MATERIALS OF CONSTRUCTION.

Carborundum.

Making Carborundum. Sturgis B. Rand. Extracts from *McClure's Mag.* Description of the hottest heat known to man and its practical uses at Niagara Falls. 3500 w. Am Mfr & Ir Wld—Jan. 25, 1900. No. 32064.

Cast Iron.

Testing Cast Iron for Ultimate Stresses. Walter J. May. Showing the results to be only comparative, and suggesting experimental work to determine the relation of test bars to large castings. 1200 w. Prac Engr—Jan. 5, 1900. No. 31-912 A.

Cast Steel.

Blacksmith Shop Study of Cast Steel. G. F. Hinkens. From a paper read before the North-West Ry. Club, U. S. A. On the treatment in tool making, the hardening and tempering, etc. 3400 w. Prac Engr—Jan. 5, 1900. No. 31910 A.

Curved Plates.

The Thickness and Form of Curved Sheet-Iron Plates (Sur l'Epaisseur et la Forme à Donner aux Tôles Embouties). Maurice Levy. An analytical and graphical investigation into the resistance of curved plates of various forms and thicknesses; applicable to boiler construction and similar work. 5000 w. Génie Civil—Dec. 30, 1899. No. 32106 D.

Investigations into the Stresses and Deformations of Curved Plates (Untersuchungen über die Formänderungen und die Anstrengung Gewölbter Böden). C. Bach. A very complete record of measurements made upon convex and concave cylinder-heads of wrought and cast iron, giving tabulated and graphical results. Two articles, two plates. 10,000 w. Zeitschr d Ver Deutscher Ing—Dec. 23, 30, 1899. No. 32110 each D.

Extensometer.

A New Extensometer. William H. Kenerson. Illustrates and describes an instrument designed by the writer, used in the testing laboratory of Brown Univ., Providence, R. I. 700 w. Eng News—Jan. 25, 1900. No. 32079.

India-Rubber.

Substitutes for India-Rubber. H. L. Terry. A general discussion of the value of these substitutes as compared with india-rubber. 2000 w. Elect'n, Lond—Dec. 29, 1899. No. 31822 A.

Testing.

Testing the Strength of Materials. Edward F. Miller. Part first deals with tension and transverse tests. Ill. 2500 w. Mach, N. Y.—Feb., 1900. No. 32254.

POWER AND TRANSMISSION.

Cables.

Notes on the Life of Steel Wire Cables. Frank Soulé. An account of tests to be made by E. H. Benjamin, to determine the effects of rust, age, wear and tear, shocks, etc. 700 w. Trans Am Inst of Min Engs—Sept., 1899. No. 31651 D.

Clutches.

Some Types of Friction Clutches. Gives the summary of the essential conditions of a clutch as given by Walter Bagshaw, discussing their uses and things to be considered before buying. Also gives illustrated descriptions of various types. 4200 w. Ir & Coal Trds Rev—Jan. 12, 1900. No. 32040 A.

Coaling.

See Marine Engineering.

Compressed Air.

Discharge of Air from Pipes under Heavy Losses of Pressure. William Cox. A valuable mathematical discussion, with numerous examples showing the practical applications of the methods of computation, also useful tables. Serial. Part I. 1200 w. Compressed Air—Jan., 1900. No. 32352.

Gas Transmission.

See Gas Engineering.

Material Transport.

See Mining and Metallurgy, Iron and Steel.

Ropes.

See Mining and Metallurgy, Mining.

Speed Indicator.

See Electrical Engineering, Measurement.

SPECIAL MOTORS.

Blowing Engine.

Blast Furnace Gas Blowing-Engine at Differdingen (Hochofengasgebläse für Differdingen). Brief description with photograph of a large blowing engine with gas-engine power cylinder operated by blast furnace gases, as recently erected at Differdingen. 500 w. Stahl und Eisen—Jan. 1, 1900. No. 32150 D.

Diesel.

The Diesel Motor (Le Moteur Diesel). C. Lambotte. A general discussion and criticism of the Diesel motor, comparing its performance with that of other internal combustion motors. 5000 w. 1 plate. Rev Univ des Mines—Dec., 1899. No. 32130 G.

The Diesel Oil Engine. An illustrated description of the theory and construction of the Diesel engine, and related information. 4800 w. Engng—Jan. 5, 1900. No. 31924 A.

Gas Engines.

Blast-Furnace Gas for Gas Engines. A review of reports on the subject in various publications. 2400 w. Eng Rec—Jan. 6, 1900. No. 31769.

Gas Engine Governing and Economy. W. H. Booth. Considers the methods of governing gas engines and the advantages of each. 900 w. Am Mach—Jan. 4, 1900. No. 31775.

Oil Motors.

Test of English Oil Engines. Brief report of trials made of ten motors at full brake load, half load, and light load, in which nine proved successful. 500 w. Am Mfr & Ir Wld—Jan. 18, 1900. No. 31972.

See Automobilism.

Vehicle Motors.

See Automobilism.

STEAM ENGINEERING.

Blower System.

See Architectural Engineering, Heating.

Blowing Engines.

Blowing Engines for the National Steel Company. Illustrated description of three interesting engines recently installed at the Ohio works. They are of the inverted marine type, with the air cylinders tandem to and above the steam cylinders. 600 w. Power—Jan., 1900. No. 31790.

Boiler Explosion.

Boiler Explosion at Sheffield. An account of the disastrous explosion on Nov. 1, at the Don Cutlery Works, and the investigation. 4500 w. Engng—Dec. 29, 1899. No. 31834 A.

Boiler Rating.

See Architectural Engineering. Heating.

Boilers.

Circulation in Steam Boilers. Editorial discussion of statements made in a paper by George Halliday, on "The Influence of Velocity on Evaporation in Tubes." 2500 w. Eng News—Jan. 18, 1900. No. 31976.

Commercial Types of Water-Tube Boilers Built in America. Part first illustrates and describes the Almy, Seabury and Niclausse boilers. 2000 w. Marine Engng—Jan., 1900. Serial. 1st part. No. 31811 C.

See Architectural Engng., Heating.

Chimney.

The Monumental Chimney of the Suffren Power House (La Cheminée Monumental de l'Usine Suffren). G. Leugny. A detailed description of the great chimney for the Power-house of the Paris Exposition, with numerous views showing successive stages of the construction. 2000 w. Revue Technique—Dec. 25, 1899. No. 32117 D.

Circulation.

The Dubian Emulseur (Note sur l'Emulseur Dubian). M. Deibrouck. Giving data and results of tests made upon boilers provided with the Dubian circulating device, showing the advantages of a vigorous circulation. 4000 w. 2 plates. Rev Univ des Mines—Dec., 1899. No. 32129 G.

Efficiency.

Investigations Upon the Increase of the Thermal Efficiency of Steam Engines (Versuche zur Erhöhung des Thermischen Wirkungsgrade der Dampfmaschen). A review of the studies of Professor Josse, of Berlin, with details of the investigations, and indicator diagrams from the 40 h.p. experimental engine. 2500 w. Glückauf—Dec. 16, 1899. No. 32154 B.

Engines.

Horizontal Tandem Steam Engine (Horizontale Tandem-Dampfmaschine). Brief description of an 800 h.p. horizontal tandem compound engine, arranged with low-pressure cylinder nearest the crank-shaft. A modified Corliss valve gear is used. 600 w. 1 plate. Stahl und Eisen—Dec. 15, 1899. No. 32147 D.

Large Electric Light Engines. R. D. Summerfield. Considers the types most used, aiming to give a general idea of the direction in which the makers are trending, and his opinion as to which type will survive. 2500 w. Elec Eng, Lond—Jan. 5, 1900. No. 31945 A.

Marine Engines (Les Machines Marines). L. E. Bertin. A very full review of modern marine engine practice, both merchant and naval, with many illustrations and diagrams. 18000 w. Bull de la Soc d'Encour—Oct., 1899. No. 32126 G.

Sulzer Triple-Expansion Engines for the Berlin Municipal Electric Lighting System. Translated from the *Schweizerische Bauzeitung*. Drawings and description of vertical two-crank engines with the cylinders arranged steeple-fashion. 900 w. Eng News—Jan. 25, 1900. No. 32076.

The Evolution of the Stationary Steam Engine. Andrew Robert Robertson. Contributed to the Inst. of Civ. Engs., England. Showing that the main features and principle of the engine as laid down by Watt differ only in detail from those employed by successive experimenters and designers. 4200 w. Col Guard—Dec. 29, 1899. No. 31837 A.

2000 I.H.P. Compound Mill Engines. Illustrated description of an improved type of compound engines in favor where large power is required. 1800 w. Engr, Lond—Jan. 12, 1900. No. 32041 A.

Feed Water.

Corrosive and Incrusto-Corrosive Waters in Steam Boilers (Eaux Corrosives et Incrusto-Corrosives dans les Générateurs de Vapeur). H. de la Coux. An exhaustive discussion of the corrosive action of the various waters met in practice, together with the best methods of relief. Three papers, 6000 w. Génie Civil—Dec. 23, 30, 1899, Jan. 6, 1900. No. 32103 each D.

Firing.

Mechanical Devices as Applied to Firing Steam Boilers. W. E. Snyder. Considers various devices, giving the results of experience. 8000 w. Pro Engs' Soc of W Penna—Dec., 1899. No. 31889 D.

Garbage Fuel.

See Civil Engineering, Municipal.

Heat Losses.

A Complete Heat Cycle for the Steam Boiler and Engine. L. C. Auldjo. Read before the Engng. Assn. of New South Wales. Describes tests made and gives results brought about by the use of this heat cycle. 2500 w. Ind & Ir—Dec. 29, 1899. No. 31818 A.

Hot Water.

See Architectural Engineering, Heating.

Indicator Diagrams.

The Influence of the Indicator Diagram on the Design of Valve Gear. Considers that ingenuity, time and money have been wasted in efforts to obtain a diagram of a particular type, and the object is not worth the cost. 3200 w. Engr, Lond—Jan. 19, 1900. No. 32209 A.

Mechanical Draft.

The Influence of Mechanical Draft Upon the Ultimate Efficiency of Steam Boilers. Walter B. Snow. A brief description of the apparatus and methods employed is given, and the factors on which the efficiency depends are discussed, showing beneficial results. Ill. 4500 w. Jour Assn of Engng Socs—Dec., 1899. No. 32017 C.

Piping.

Power Plant Piping and Accessories. William D. Ennis. Considers the principles of design and discusses the high pressure steam pipes, in the present article. Ill. 3000 w. St Ry Rev—Jan. 15, 1900. No. 31998 C.

Pressure.

Table Showing the Loss of Pressure in Steam Pipes. A. F. Nagle. 250 w. Eng News—Jan. 25, 1900. No. 32073.

Steam Power.

The Economical Generation of Steam Power. B. A. Tapp. Considers some of the recent devices for improving the efficiency. 1800 w. Elec Eng, Lond—Jan. 5, 1900. Serial. 1st part. No. 31947 A.

Superheating.

The Production and Utilization of Superheated Steam. R. S. Hale. A study of the modern devices for superheating steam, and the best methods of applying it in order to realize the highest economy. 3000 w. Engineering Magazine.—Feb., 1900. No. 32195 B.

Valve Motion.

Mistakes in Designing Valve Motion. H. Rolfe. Enumerates disadvantages met, and points needing correction. 1400 w. Loc Engng—Jan., 1900. Serial. 1st part. No. 31676 C.

Winding Engines.

See Mining and Metallurgy, Mining.

MISCELLANY.

Liquid Air.

A Liquid Air Plant. Illustrates and describes the plant of Ostergren & Berger, New York City, the machinery, process, etc. 2000 w. Ice & Refrig—Jan., 1900. No. 31675 C.

Mathematics.

Mathematics in the Mechanical Trades. J. S. Plaskett. Read at Univ. of Toronto. Shows the advantage of a mathematical training and outlines a course that should be given. Ill. 2800 w. Can Engr—Jan., 1900. No. 31948.

Mechanical Progress.

The Progress in the Mechanical Arts in Three-quarters of a Century. Coleman Sellers. An address delivered at the National Export Exposition on the occasion of the celebration of the 75th anniversary of the Franklin Inst. 7200 w. Jour Fr Inst—Jan., 1900. No. 31868 D.

Patents.

An Important Patent Decision. Arthur F. Kinnan. A criticism on a decision rendered by the United States Court of Appeals for the Dist. of Columbia, in the case of Bechman vs. Wood. 2800 w. Elec Wld & Engr—Jan. 20, 1900. No. 32006.

Planimeter.

The Lippincott Planimeter. A. G. Greenhill. Illustrated description of the instrument and its use. 1800 w. Engr, Lond—Dec. 22, 1899. No. 31728 A.

Printing.

Recent Advances in the Graphic and Photographic Arts (Ueber einige Neuere Arbeiten im Geibeite der Graphischen Künste und der Photographic). Ottomar-Volkmar. Describing especially improved methods of photo-engraving and printing from aluminum plates, with illustrations of presses. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 22, 1899. No. 32115 B.

Refrigeration.

European Refrigerating Practice. A. J. Wallis-Tayler. Part first describes the Yaryan system of distilling apparatus. Ill. 1100 w. Mod Mach—Jan., 1900. Serial. 1st part. No. 31661.

Mechanical Refrigeration. Otto Luhr. Gives a brief description of the essentials of the system, and the principles of operation. 3200 w. Power—Jan., 1900. No. 31791.

Review.

A Look Back and a Glance Forward. An interesting review of changes during the last century, and remarks on the possibilities of the future. 1800 w. Eng & Min Jour—Jan. 13, 1900. No. 31891.

Shield.

Devices for Attacking Trenches. Illustrated description of a steel shield made to be used on a rifle or to build up defence. 1600 w. Engr, Lond—Jan. 12, 1900. No. 32042 A.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

On the Determination of Volatile Combustible Matter in Coke and Anthracite Coal. Richard K. Meade and James C. Attix, in *Jour. Am. Chem. Soc.* Describes an investigation looking toward a more satisfactory method of determining volatile combustible matter. 2500 w. Am Gas Lgt Jour—Jan. 8, 1900. No. 31779.

See Gas Engineering.

Coal Pits.

The Ocean Coal Company's Deep Navigation Pits at Treharris. An illustrated account of these Welsh collieries, and of recent improvements. 5000 w. Ir & Coal Trds Rev—Jan. 19, 1900. No. 32219 A.

Coal Production.

Coal in 1899. Reports for the year showing the largest output on record, and giving interesting information. 9800 w. Eng & Min Jour—Jan. 6, 1900. No. 31788.

Coke.

Natural Coke of the Santa Clara Coal-Field, Sonora, Mexico. E. T. Dumble. A description of deposits of interest and value. 1400 w. Trans Am Inst of Min Engs—Sept., 1899. No. 31652 D.

Coking.

The Hemingway Coking Process. Illustrates and describes a process for coking low-grade Western coal. 1400 w. Ir Age—Jan. 18, 1900. No. 31967.

Compensation.

The Workmen's Compensation Act in Relation to Collieries. Statements based upon information gathered from leading insurance officials and other authorities, respecting the operation of this act as regards collieries. 1400 w. Col Guard —Jan. 12, 1900. No. 32039 A.

Indiana.

Coal Mining in Indiana. George H. Ashley. Abstracted from the annual report of the Dept. of Geol. and Nat. Resources of the State of Indiana. Illustrated description of the methods used for haulage and ventilation and for preparing the coal for market. 3800 w. Mines & Min—Jan., 1900. No. 31850 C.

New Zealand.

Notes on the Coalfields of New Zealand. James Park. Read before the Inst. of Min. and Met., London. Concerning the physical character and composition, and an estimate of quantity. 2000 w. Col Guard—Dec. 29, 1899. No. 31836 A.

South Africa.

The Vereeniging Collieries. An illustrated description of this important industry of South Africa. 2800 w. Ir & Coal Trds Rev—Jan. 5, 1900. No. 31933 A.

Thin Seams.

Winning the Seams in the Dortmund Coalfield. From a communication to *Glückauf*. Illustrates and describes a method of working out the coal with gobbing the spaces. 1700 w. Col Guard—Jan. 12, 1900. No. 32036 A.

Trade.

Notes on Foreign Coal and Coke Trades in 1899. Notes on the trade of Germany, France, Belgium, Austria-Hungary, New Zealand, etc. 4800 w. Ir & Coal Trds Rev—Jan. 5, 1900. No. 31932 A.

The Coal and Coke Trades in 1899. A general review and also articles by able writers reviewing various districts of Great Britain. Maps. 11500 w. Ir & Coal Trds Rev—Jan. 5, 1900. No. 31931 A.

The Coal Trade in 1899. Discusses each of the districts in Great Britain, and reports general prosperity. 11200 w. Col Guard—Jan. 5, 1900. No. 31928 A.

COPPER.

Arizona.

The Copper Queen Mine, Arizona. James Douglas. An illustrated description of the deposits and their working, with account of the discovery of the mine and other information. 8500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 31655 D.

Formation.

Notes on the Formations of Copper "Trees" and "Nodules." Sherard Cowper-Coles. Illustrates and describes formations of electro-deposited copper, discussing the causes. 400 w. Elect'n, Lond—Dec. 22, 1899. No. 31714 A.

Production.

Copper in 1899. Information concerning the production, with reports of the New York and London copper markets. 7000 w. Eng & Min Jour—Jan. 6, 1900. No. 31782.

Copper Production and Values. Editorial review of the copper situation. 1800 w. Engng—Jan. 19, 1900. No. 32216 A.

The Copper Industry. Reviews the developments of 1899 and the future outlook. 2300 w. Ir Age—Jan. 4, 1900. No. 31750.

Standards.

Proposed Standards for Copper Specifications. Gives the report of the committee appointed to determine a standard for copper conductors, with editorial comment. 2800 w. Elect'n, Lond—Dec. 22, 1899. No. 31715 A.

Superior.

Lake Superior Copper Mines. Dwight E. Woodbridge. Information concerning the output of the older mines and the great development of the new ones during the past year. 2200 w. Mines & Min—Jan., 1900. No. 31853 C.

GOLD AND SILVER.

British Columbia.

The Progress of Mining in British Columbia During 1899. A general review which is most encouraging. 1500 w. B. C. Min Rec—Jan., 1900. No. 31943 C.

California.

California Mining. Arthur Lakes. Gives the history of mining in the Nevada City and Grass Valley regions, with description of the geology of the veins. Ill. 3500 w. Mines & Min—Jan., 1900. No. 31851 C.

Cape Nome.

Some Notes on Nome, Alaska. Paul F. Travers. An account of the discovery, and of the present outlook and conditions. Ill. 1200 w. Eng & Min Jour—Jan. 27, 1900. No. 32094.

The Cape Nome Gold Fields. Concerning the gold discoveries reported, with tables giving market quotations, and other information. 800 w. U. S. Cons Repts, No. 633—Jan. 20, 1900. No. 31983 D.

Colorado.

Cripple Creek, Colorado, Mines in 1899. Notes on the mining progress. 1200 w. Eng & Min Jour—Jan. 13, 1900. No. 31897.

Gilpin County, Colorado, Mines in 1899. Shows a very prosperous year, and gives information of interest. 1200 w. Eng & Min Jour—Jan. 13, 1900. No. 31895.

Leadville, Colorado, Mines in 1899. Comments on the general conditions of mining during the year. 1800 w. Eng & Min Jour—Jan. 13, 1900. No. 31896.

The La Plata Mountains of Colorado. Arthur Lakes. An illustrated description of the telluride veins and the Mancos Contact. 2700 w. Mines & Min—Jan., 1900. No. 31856 C.

Cyanide.

The Cyanide Plant of the Rose Gold

Mining Company at Victor, California. Charles T. Arkins. Brief illustrated description. 600 w. Eng & Min Jour—Jan. 13, 1900. No. 31893.

Cyaniding in New Zealand. James Park. Describes the geological conditions of the Hauraki peninsula and the treatment of the ores. 5500 w. Trans Am Inst of Min Engs—Sept., 1899. No. 31654 D.

Distribution.

The Wide Distribution of Gold. Arthur Lakes. New and unexpected formations in which it is often found, and why new districts are not often discovered. 1600 w. Mines & Min—Jan., 1900. No. 31849 C.

Dredging.

Dredging: Its Present and Future Outlook. J. G. Hyde. From the inspecting engineer's report. Considers the chief difficulties to be overcome, and improvements needed. 1000 w. N. Z. Mines Rec—Nov. 16, 1899. No. 31707 B.

The Origin and Progress of Gold Dredging in New Zealand. W. H. Cutten. A fully illustrated paper showing the methods of operating the gold dredging apparatus in the waters of New Zealand, and the wonderfully rich results which have been obtained. 3000 w. Engineering Magazine—Feb., 1900. 32193 B.

The Waiau River as a Gold-Dredging Channel. Ro. Carrick. Gives a description of dredging ground peculiar to this basin. 1600 w. N. Z. Mines Rec—Nov. 16, 1899. No. 31708 B.

Klondike.

A Year's Progress in the Klondike. Angelo Heilprin. An interesting illustrated description of the improvements in Dawson, and in means of communication with the outside world, the mining outlook, etc. 2800 w. Ap Pop Sci M—Feb., 1900. No. 32016 C.

The Economics of the Klondike. Jack London. Considers the profits and losses of the rush to this region, and what the ultimate outcome will be. Ill. 2500 w. Rev of Revs—Jan., 1900. No. 31757 C.

Production.

Gold and Silver in 1899. An estimate of the gold production of the world during this year. 6000 w. Eng & Min Jour—Jan. 6, 1900. No. 31783.

Proof.

Proof Gold and Silver. Cabell Whitehead. Describes the method of preparing pure gold and silver in use at the mints. 1100 w. Eng & Min Jour—Dec. 30, 1899. No. 31665.

Valuation.

The Valuation of Gold Concessions in the Transvaal (L'Evaluation des Concessions Aurifères au Transvaal). G. Braecke. A description of the methods employed in sampling and assaying the deposits; also of estimating the working expenses, in order to arrive at the commercial value of a claim. 5000 w. Rev Univ des Mines—Dec., 1899. No. 32128 G.

Washington.

Lake Chelau District. Arthur Lakes. An illustrated account of an undeveloped mining district in the State of Washington. 3000 w. Mines & Min—Jan., 1900. No. 31855 C.

IRON AND STEEL.

Blowing Engine.

See Mechanical Engineering, Special Motors.

Casting.

The Uehling Casting Machine (Die Uehlingsche Giessmaschine). Ed. A. Uehling. A paper read before the Eisenhütte Düsseldorf devoted mainly to a description of the operation of the Uehling casting machine at the Carnegie Works in Pennsylvania. 2000 w. Stahl und Eisen—Jan. 1, 1900. No. 32149 D.

Classification.

Metric Classification of German Iron Manufactures. A copy of the classification of German iron manufactures as given in the report of the British Consul. 700 w. U. S. Cons Repts, No. 635—Jan. 23, 1900. No. 32012 D.

Germany.

The German Iron Industry in the Year 1899. Emil Schroedter. Reports a very prosperous year for both iron and coal. 1900 w. Ir & Coal Trds Rev—Dec. 29, 1899. No. 31825 A.

The Iron and Steel Industries of Germany. R. M. Daelen. Shows the recent development of the iron industry, and the improvements in the works. 3800 1900 w. Ir & Coal Trds Rev—Dec. 29, 1899. No. 31824 A.

High Temperatures.

The Color Names for High Temperatures. Henry M. Howe. Compares results of Messrs. White and Taylor, and the writer with Pouillet's data concerning colors of heated steel, and advises the abandoning the latter. 1200 w. Eng & Min Jour—Jan. 20, 1900. No. 32009.

Iron.

Some Phenomena Presented by Iron (Sur quelques Phénomènes que présente le Fer). M. Galy-Aché. An examination of phenomena relating to allotropic forms of iron, including behaviour under high pressures and under rapid cooling. 1200 w. Comptes Rendus—Dec. 26, 1899. No. 32125 D.

Iron Ore.

Greatest Lake Iron Ore Output. Horace J. Stevens. Review of the tonnage during this and past years, giving estimates of future outputs. 3000 w. Am Mfr & Ir Wld—Jan. 4, 1900. No. 31754.

Iron Trade.

Our Review of the Iron and Steel Trades in 1899. A review of British imports and exports, and report dividends paid. 4400 w. Ir & Coal Trds Rev—Dec. 29, 1899. No. 31823 A.

The Chicago Iron Trade in 1899. Reviews the general features, and also the trade by months, giving tables of prices, and reporting a very encouraging outlook. 5000 w. Ir Age—Jan. 4, 1900. No. 31748.

The Philadelphia Iron Trade in 1899. Thomas Hobson. Review of the most eventful year ever experienced. 3000 w. Ir Age—Jan. 4, 1900. No. 31747.

The Pittsburg Iron Trade in 1899. Robert A. Walker. Report of the greatest year the iron trade has ever known, discussing details. 12500 w. Ir Age—Jan. 4, 1900. No. 31749.

Japan.

Japanese Steel Works, Yawatamura. An account of two blast furnaces being erected for the making of rails, rods, sheets, and cast-steel. 1200 w. Am Mfr & Ir Wld—Jan. 18, 1900. No. 31973.

The Recent Industrial Development of Japan (Die Neuere Industrielle Entwicklung Japans). Especially discussing the iron and steel industry, with plan and illustrations of the Imperial Japanese Steel Works at Yawatamura. 3000 w. Stahl und Eisen—Dec. 15, 1899. No. 32145 D.

Madagascar.

The Iron Industry of Madagascar (L'Industrie du Fer à Madagascar). A review of the tour of investigation recently made by M. Breton, showing the presence of workable deposits of iron ore in various parts of the island. 2000 w. Moniteur Industriel—Jan. 6, 1900. No. 32184 F.

Manufacture.

Iron and Steel Works Plant. Harry B. Toy. Read before the South Staffordshire Iron and Steel Inst. Describes an economical plant for producing about 1000 tons per month of iron bars, criticising in detail. 3800 w. Col Guard—Dec. 22, 1899. No. 31734 A.

Manufacture of Iron in the East. B. H. Thwaite. Reviews the history of this industry and discusses the advisability of increasing the production in colonies possessing the raw materials. Ill. 1800 w. Ind & East Engr—Dec., 1899. No. 31969 D.

The Manufacture of Iron and Steel in India. R. H. Mahon. Abstract of a report to the Indian Government, 1899. Information relating to the capability of India for steel manufacturing. Map. 5700 w. Col Guard—Jan. 19, 1900. Serial. 1st part. No. 32233 A.

Material Transport.

Economy in the Transport of Raw Materials in Iron Manufacture (Ersparnisse in der Bewegung der Rohstoffe für die Eisendarstellung). E. Schrödter. A paper before the December convention of the Verein Deutscher Eisenhüttenleute discussing railway tariffs, and transport facilities for iron ore, fuel, etc., also the use of mechanical conveyors, etc., also discussion. 8000 w. Stahl und Eisen—Jan. 1, 1900. No. 32148 D.

Merchant Bar.

The Continuous System as Applied to the Rolling of Merchant Steel. Illustrated description of the system and plant. 1500 w. Ir Age—Jan. 18, 1900. No. 31966.

Nickel-Steel.

Nickel-Steel; A Synopsis of Experiment and Opinion. David H. Browne. Discusses the physical qualities of nickel and nickel-steel and the various uses of the metal. Ill. 21500 w. Trans Am Inst of Min Engs—Sept., 1899. No. 31656 D.

Production.

Iron and Steel. Report of the year 1899, showing great prosperity and productiveness. 7500 w. Eng & Min Jour—Jan. 6, 1900. No. 31784.

Steel.

The Effect of Heat-Treatment Upon the Physical Properties and the Microstructure of Medium Carbon Steel. Robert Gorham Morse. Gives results of investigations to determine how the tensile strength, the elastic limit, and the size of the grain, of a pure medium-carbon steel are affected by heating to successive temperatures between 500° and 1300° C., with slow cooling therefrom. Ill. 2500 w. Trans Am Inst of Min Engs—Sept., 1899. No. 31650 D.

Superior.

Lake Superior Iron Mines in 1899. Review of the ore shipments, mining purchases, and other matters of interest. 2000 w. Eng & Min Jour—Jan. 13, 1900. No. 31894.

Utah.

Utah Mines in 1899. Notes on the mining conditions in the State. 1500 w. Eng & Min Jour—Jan. 13, 1900. No. 31898.

Wire.

Recent Progress in Wire Manufacture. Briefly reviews the history of wire-making, and gives an illustrated description of the recent English plant of the Bedson Wire Works in Middlesbrough. 3000 w. Ir & Coal Trds Rev—Dec. 22, 1899. No. 31720 A.

Wire and Wire-Drawing. J. Dixon Brunton. Abstract of a paper read before the West of Scotland Ir. and Steel Inst. Some of the important uses of wire are given, and the operation of drawing described, and other processes in its manufacture. 2500 w. Ir & Coal Trds Rev—Jan. 19, 1900. No. 32220 A.

MINING.

Austria.

The Mining Products of Austria in 1898 (Die Bergwerks produktion Oesterreichs in Jahre, 1898). An abstract of the official report, giving tables of both raw and manufactured mineral products, both as to weight and market value. 1500 w. Glückauf—Dec. 15, 1899. No. 32156 B.

Accidents.

Fatal Accidents in Coal Mining in North America. Frederick L. Hoffman. Data for the year 1898 and explanatory information for the previous nine years. 1300 w. Eng & Min Jour—Jan. 27, 1900. No. 32095.

Belgium.

The Belgian Mining Industry for 1898 (Die Belgische Bergwerksindustrie im Jahre, 1898). A detailed abstract of the official report of the Belgian government, including coal, coke, metallic ores and operating statistics. 1800 w. Glückauf —Dec. 23, 1899. No. 32159 B.

Colorado.

San Miguel County, Colorado, Mines in 1899. Reviews the work of this district for the past year. 3000 w. Eng & Min Jour—Jan. 20, 1900. No. 32011.

Drilling.

Diamond Drilling Machines. H. M. Lane. Gives some of the peculiarities, advantages and disadvantages of the different types of machines in use, describing the feed arrangements, methods of uncovering the hole, hand drills and their capabilities, and a few facts as to costs. 4400 w. Mines & Min—Jan., 1900. No. 31848 C.

Electric Power.

The Application of Electric Power to Mining in British Columbia. George P. Low. A brief account of the Kootenay-Rossland transmission. 3400 w. Can Min Rev—Dec. 31, 1899. No. 31698 B.

Errors.

Mining Errors. F. Danvers Power. Read before the New South Wales Chamber of Commerce. Notes on a few of the principal errors that are found in the practice of mining, especially in prospecting, promoting and managing. 6700 w. Can Min Rev—Dec. 31, 1899. No. 31697 B.

Explosives.

A New "Permitted" Gunpowder. Donald M. D. Stuart. Some information concerning high-grade gunpowders, with illustrations of shots in blasting work. 1600 w. Col Guard—Jan. 19, 1900. No. 32234 A.

The Application of Explosives. Charles E. Munroe. Illustrates and describes some of the methods of producing explosives and also their applications. 2500 w. Ap Pop Sci M—Jan., 1900. Serial. 1st part. No. 31657 C.

The Use of Explosives in Belgian Collieries. Victor Watteyne. From a communication to the *Annales des Mines de Belgique.* Information concerning the quantities used, and the progress in safety. 2200 w. Col Guard—Jan. 5, 1900. No. 31930 A.

Firedamp.

The Ignition of Firedamp and Coal Dust by Means of Electricity. Sydney F. Walker. Gives a résumé of the contents of a paper by Bergassessor Heise and Dr. Theim recording experiments on this subject, and considers the results. 3000 w. Col Guard—Jan. 12, 1900. Serial. 1st part. No. 32037 A.

Haulage.

Slope No. 6, Pratt City, Alabama. Neill Hutchings. An example of endless rope haulage is described. 1300 w. Mines & Min—Jan., 1900. No. 31852 C.

Laccolites.

Laccolites and Their Relation to Ore Deposits. Illustrated description of interesting geological features, showing the difference between postular uplifts and true laccolites. 1700 w. Min & Sci Pr—Dec. 30, 1899. Serial. 1st part. No. 31695.

Machinery.

The Machinery in the Transvaal Gold Mines (Die Maschinen in den Goldgruben Transvaals). Kurt Schweder. An account of the engines, compressors, pumps and other machinery in the Transvaal mining country, showing the very high grade and modern character of the plants. 2500 w. Glückauf—Dec. 16, 1899. No. 32155 B.

Mexico.

Mexican Resources. J. W. Gray. An account of the country, its natural riches, and the opportunities they offer for profitable development. 1200 w. Mines & Min—Jan., 1900. No. 31854 C.

Mine Water.

See Mechanical Engineering, Hydraulics.

Mining Capital.

The Redemption of Capital Expenditure upon Collieries and the Valuation of Mining Capital, etc. George Johnson. Discusses the different ways and means which may be employed to attain this object. 2200 w. Col Guard—Jan. 12, 1900. No. 32038 A.

Mining Law.

The Calhoun-Ajax Case. The Rights of Tunnels and of Locations on Cross Veins. A recent decision of the Supreme Court of Colorado on a subject of importance. 4800 w. Eng & Min Jour—Dec. 30, 1899. No. 31663.

Mining Plant.

See Electrical Engineering, Power Applications.

Ores.

Notes on Ore Dressing. A. W. Warwick. Briefly notes the ancient systems, and the modern improvements, the course of treatment in a wet plant and a few principles governing the design of a perfect mill. 1700 w. Min & Sci Pr—Jan. 13, 1900. No. 31971.

Ropes.

The Use of Slow-Moving Belt Ropes in Shafts. Harry Rhodes. Part first considers the advantages of this form of power transmission, and some of the details in the installation of such a plant. Ill. 1700 w. Prac Engr—Jan. 19, 1900. Serial. 1st part. No. 32231 A.

Saxony.

The Mining Statistics of the Kingdom of Saxony for 1898 (Statistik des Bergbaues im Königreich Sachsen für das Jahr, 1898). A tabulated abstract from the official Government report. 800 w. Glückauf—Dec. 23, 1899. No. 32158 B.

Separation.

The Wet Separation of Ores and Minerals. Walter J. May. Discusses some points in the methods used. 1800 w. Prac Engr—Jan. 5, 1900. No. 31911 A.

Shaft Accidents.

Arrangements for Preventing Shaft Accidents. M. Thiriart, in *Annales des Mines de Belgique.* Description of arrangements applied, and discussion of objections. Ill. 1700 w. Col Guard—Jan. 19, 1900. No. 32232 A.

Shafts.

Boring a Pair of Winding Shafts at the Bois-du-Luc Collieries. A. Demeure. From a communication to the *Annales des Mines de Belgique.* Illustrated detailed description. 3300 w. Col Guard—Dec. 22, 1899. No. 31735 A.

Means for Preventing Shaft Accidents. Leon Thiriart. From a communication to the *Annales des Mines de Belgique.* Illustrated description of arrangements for enclosing cages during the travelling of workmen, and for weekly inspections, etc. 3000 w. Col Guard—Dec. 29, 1899. No. 31835 A.

Sinking Through Heavily Watered Strata. Richard Robinson. Read before the British Soc. of Min. Students. Directions, with illustrations. 1700 w. Ir & Coal Trds Rev—Jan. 19, 1900. No. 32218 A.

Stopes.

A New Method of Measuring Stopes. Fred T. Greene. Illustrated description. 600 w. Eng & Min Jour—Jan. 27, 1900. No. 32096.

Timbering.

A New Method of Coal Mining (Nouvelle Méthode d'Exploitation de la Houille). Describing method of timbering in the Grand Combe coal mines, by which the efficiency of operation is materially increased. 1200 w. Génie Civil—Dec. 16, 1899. No. 32101 D.

The Main Difficulty of the Timbering Problem. H. W. Halbaum. Examines a case of accident with the view of showing the difficulties to be overcome in the solution of timbering problems. Ill. 3500 w. Col Guard—Dec. 22, 1899. Serial. 1st part. No. 31732 A.

Ventilation.

Mine Ventilation. James Grant. Describes and discusses the three methods employed, and the difficulties. 3000 w. Aust Min Stand—Nov. 30, 1899. Serial. 1st part. No. 31710 B.

Sources of Error in the Proportioning of Mine Workings (Ueber die Fehlerquellen bei der Bestimmung der Grubenweiten). L. Volf. A detailed discussion of the method of computing the proper dimensions for passages in mines, with especial reference to the Murgue system of ventilation. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 30, 1899. No. 32161 B.

Winding Engines.

Experiments with Compound Winding Engines. J. Divis. *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Report of tests made to gain information of the relative superiority of compound *versus* non-compound engines for winding in mines. 1000 w. Col Guard—Dec. 22, 1899. No. 31733 A.

MISCELLANY.

Aluminum.

See Electrical Engineering, Miscellany.

Kimberley.

The Diamond Mines of Kimberley. History of the discovery and working of this great diamond field. Ill. 1400 w. Sci Am—Jan. 27, 1900. No. 32048.

Lead.

Lead in 1899. Report of the production in the United States and of the New York and London markets. 2200 w. Eng & Min Jour—Jan. 6, 1900. No. 31785.

Minerals.

The Metal and Mineral Output of the United States in 1899. A summary of the production of the more important metals and minerals. 3200 w. Eng & Min Jour—Jan. 6, 1900. No. 31781.

Ore Transportation.

Iron Ore—From Mine to Furnace. Waldon Fawcett. Illustrated description of transportation facilities from Lake Superior mines to the vicinity of Pittsburg. 1300 w. Eng & Min Jour—Jan. 20, 1900. Serial. 1st part. No. 32010.

Peat.

The Use of Peat as Fuel. Gives a brief account of efforts to turn bog lands to account, and the uses for which peat is adapted, and its proper preparation. 1400 w. Col Guard—Jan. 5, 1900. No. 31929 A.

Petroleum.

Petroleum in 1899. Reports an improvement in the production in the United States, and encouraging features of the industry. 1000 w. Eng & Min Jour—Jan. 6, 1900. No. 31789.

Quartz.

The O. P. Q. Quartz-Mine, Waipori, Otago. Describes the working and the working plant. 1700 w. N. Z. Mines Rec—Nov. 16, 1899. No. 31709 B.

Saltpetre.

The Occurrence and Manufacture of Chili Saltpetre. A lecture by Dr. Weitz, in Berlin. Illustrated description of the deposits and the production. 3000 w. Ir & Coal Trds Rev—Dec. 29, 1899. No. 31826 A.

Schist.

The Bituminous Schist Industry in France (L'Industrie des Schistes Bitumineux en France). A comparison of the French and Scotch industries, calling attention to the superior output of mineral oil, paraffine, etc., obtained by the Scotch process of distillation. 1800 w. Moniteur Industriel—Dec. 30, 1899. No. 32183 F.

Smelting.

Silver and Lead Losses in Lead Smelting. L. D. Godshall. Discusses statements made and conclusions drawn by Dr. Iles. 2400 w. Eng & Min Jour—Jan. 13, 1900. No. 31892.

Tin.

Lode Tin Mining in the Malay Peninsula. W. H. Derrick. Abstract of paper read before the Inst. of Min. and Met., Lond. Notes on vein mining, describing methods of mining and dressing the ore. 1700 w. Eng & Min Jour—Dec. 30, 1899. No. 31664.

Tin in 1899. Shows the tin received from foreign markets, and gives reports of the trade in New York and London. 3500 w. Eng & Min Jour—Jan. 6, 1900. No. 31786.

Unloader.

See Mechanical Engineering, Power and Transmission.

Zinc.

Zinc in 1899. Report of production and the markets. 4200 w. Eng & Min Jour—Jan. 6, 1900. No. 31787.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Employees.

Railroad Relief and Beneficiary Associations. W. H. Baldwin, Jr. Address before the Am. Econ. Assn., Ithaca, N. Y. Considers the development of these features of railroad organization, and their bearing upon the relations between corporations and their employees. 4000 w. Ry Age—Jan. 12, 1900. No. 31902.

Fast Run.

A Fast American Run. Hiram Percy Maxim. An account of a run from Atlantic City to Philadelphia on a Columbia electric automobile, which is supposed to be the fastest long-distance run made by an electric automobile. Ill. 1600 w. Auto Mag—Jan., 1900. No. 31689 C.

France.

A View of the Recent Improvements in Railway Service in France (Coup d'Oeil sur les Récentes Améliorations Réalisées par les Grandes Compagnies Françaises de Chemins de Fer). A. Mange. A discussion of the improvements in the interest of travelers which have been made in France during the past ten years, both as regards tariffs and improved accommodations. 6000 w. Rev Gen des Chemins de Fer—Jan., 1900. No. 32136 G.

The French Winter Train Service. Charles Rous-Marten. Gives a list of the chief expresses in France, with comments on the progress with respect to speed. 800 w. Engr, Lond—Dec. 22, 1899. No. 31729 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Testing Cock for Air Brakes. J. P. Kelly. Illustrates and describes the writer's design. 900 w. Loc Engng—Jan., 1900. No. 31678 C.

The First Air Brake—A Short History; also Reminiscences of Its First Engineer. An interesting illustrated account of the first air-braked train. 2000 w. Loc Engng—Feb., 1900. No. 32243 C.

Bogie Wagons

Fifty-Ton Bogie Wagons for the Caledonian Railway. Illustrations showing details, also brief description. 500 w. Engng—Jan. 19, 1900. No. 32215 A.

Car Lighting.

A New System for the Electric Lighting of Railway Carriages (Ein Neues System der Elektrischen Beleuchtung von Eisenbahnwagen). H. Massenbach. A paper before the Frankfurt Electrotechnical Society discussing the Pollak system, which employs a generator driven by the car axle, a small storage battery, and an automatic switch. 3500 w. Elektrotech Zeitschr—Jan. 11, 1900. No. 32173 B.

Coal Cars.

36-Foot 80,000-Pound Coal Cars. S. S. Stiffey. Illustrates and describes cars weighing 29,000 pounds, built of wood and having the side boards outside of the stakes. 600 w. Am Engr & R R Jour—Jan., 1900. No. 31680 C.

Counterbalancing.

A New Method of Counterbalancing Locomotives. Describes a system invented by P. Z. Davis. Ill. 800 w. Ry Age—Jan. 26, 1900. No. 32236 D.

Electric Traction.

Electric Traction in Railway Work. Abstract of a paper read before the Glasgow and West of Scotland Technical College Scientific Society. Discusses the advisability of substituting electric traction on steam roads. 2700 w. Tram & Ry Wld—Jan. 11, 1900. No. 32068 A.

Freight Cars.

Character of Breakages Shown in Service of Modern Freight Cars. Editorial discussion of defects arising in operation, and the treatment these heavy cars receive. 1200 w. Ry & Engng Rev—Jan. 27, 1900. No. 32238.

Injectors.

A Little About Injectors. C. B. Conger. A plain talk for railway engineers and firemen about operation of these instruments. 2400 w. Loc Engng—Feb., 1900. No. 32239 C.

Locomotives.

American Locomotives in England 60 Years Ago. W. H. Lewis. A letter concerning the Norris engines on the Birmingham & Gloucester railway in 1840. 400 w. Loc Engng—Feb., 1900. No. 32242 C.

Brooks Eight-Wheel Passenger Locomotive—C. & A. Ry. Illustrated detailed description. 1500 w. Ry & Engng Rev—Jan. 20, 1900. No. 32045.

Compound Express Engine. Illustrates and describes a Northern Counties of Ireland express engine, giving the running time. 600 w. Engr, Lond—Jan. 5, 1900. No. 31920 A.

Exhaust and Draft in Locomotives. From the report of C. H. Quereau. Gives a summary of American practice, with discussion and conclusions. 4300 w. R R Gaz—Jan. 19, 1900. No. 31978.

French Fast-Passenger Locomotive. Illustrated detailed description of engine used on the Chemin de Fer du Nord. 600 w. Ry & Engng Rev—Dec. 30, 1899. No. 31693.

Narrow-Gauge Locomotive. Illustrated description of a narrow-gauge, side tank locomotive, one of six constructed for the Sierra Leone Ry. 800 w. Engr, Lond—Jan. 12, 1900. No. 32043 A.

Some Veteran Locomotives. Alfred R. Bennett. Illustrates and describes some engines built in 1846 and 1847 in daily work on the Main-Neckar Ry. of Germany. 500 w. Engng—Jan. 12, 1900. No. 32035 A.

Ten-Wheel Tandem Compound Passenger Locomotive of the Atchison, Topeka & Santa Fe Ry. Illustrated detailed description. 1100 w. R R Gaz—Jan. 12, 1900. No. 31873.

The New Compound Express Locomotive for the North-Eastern Railway of Switzerland (Die Neue Verbund-Schnellzugs-Lokomotive der Schweizerischen Nordostbahn). A general specification of this two-cylinder compound, with sectional view, and indicator diagrams taken at speeds from 36 to 48 miles per hour. 1800 w. 1 plate. Schweizerische Bauzeitung—Dec. 30, 1899. No. 32138 B.

Lubrication.

Packing and Lubrication. A copy of the general instructions recently put in force on the New York Central & Hudson Riv. R. R. 2800 w. R R Gaz—Jan. 26, 1900. No. 32082.

Metal Cars.

The Goodwin Steel Car in Collision. John M. Goodwin. Illustrated description, showing recent progress in metal car construction. 900 w. R R Gaz—Jan. 12, 1900. No. 31875.

St. Gothard.

The New Equipment of the St. Gothard Railway (Le Matériel Nouveau du Chemin de Fer du Gothard). M. Lancrenon.

A very full account of the heavy new engines and carriages for the St. Gothard railway, with numerous illustrations and a diagram showing the increased traffic. 3000 w. 3 plates. Rev Gen des Chemins de Fer—Dec., 1899. No. 32133 G.

Siege Train.

Siege Train for the War. Illustrates the trucks and locomotives forming the train supplied to the British war office, giving an account of the rapid work in connection with the order. 1300 w. Engr, Lond—Jan. 19, 1900. No. 32211 A.

Staybolts.

Flexible Staybolts. F. W. Johnstone. Illustrates and describes these staybolts as applied on the locomotives of the Mexican Central railroad. 2300 w. Am Engr & R R Jour—Jan., 1900. No. 31679 C.

Steel Cars.

The Development of the Steel Car. Notes on the large number of cars in service and in demand, giving some of the troublesome features. 1500 w. Am Engr & R R Jour—Jan., 1900. No. 31-681 C.

Transfer Table.

The Electric Transfer Table of the Orleans Railway (Le Chariot Transbordeur Electrique de la Compagnie d'Orleans). M. Sabouret. Describing an improved electric transfer table, requiring no pit to be excavated; the whole structure being above the main track level. 2500 w. 1 plate. Rev Gen des Chemins de Fer—Dec., 1899. No. 32134 G.

PERMANENT WAY AND FIXTURES.

Boston.

The South Terminal Station, Boston, Mass. George B. Francis. An illustrated detailed description of the engineering features. 17500 w. Pro Am Soc of Civ Engs—Dec., 1899. No. 31-703 E.

Coaling Station.

The 600-Ton Coaling Station of the Lehigh Valley Railroad. An illustrated detailed description of a recently completed station at South Plainfield, N. J. 1200 w. R R Gaz—Jan. 5, 1900. No. 31758.

Crossings.

Grade Crossings. Augustus Mordecai. Brief discussion of the rights of parties interested and the justice each should be awarded. 2700 w. Jour Assn of Engng Socs—Dec., 1899. No. 32019 C.

English Railways.

The Early Railways in Surrey. Gives the history of the Surrey Iron Railway, the first one sanctioned by Parliament, and its failure, in the present article. 3800 w. Engr, Lond—Jan. 5, 1900. Serial. 1st part. No. 31919 A.

Grades.

Momentum Grades. C. Frank Allen. Explains the principle involved in the use of these grades, and discusses the objections to their indiscriminate use. 2400 w. R R Gaz—Jan. 12, 1900. No. 31872.

Theory of Velocity Grades. Two letters to the editor criticising Mr. Wentworth's explanation, and his tractive force formula. 2000 w. R R Gaz—Jan. 26, 1900. No. 32080.

Manchester.

The Great Northern Railway in Manchester. Illustrated description of the new Deansgate station and warehouse. 1700 w. Transport—Jan. 19, 1900. No. 32244 A.

Review.

A Half Century of Railway Building. Gives a comparison by decades, with diagrams. 600 w. Ry Age—Jan. 12, 1900. No. 31901.

Siberian.

My Journey on the Siberian Railway (Meine Fahrt auf den Sibirischen Eisenbahnen). Nicholaus Post. An engineer's account of observations on the Trans-Siberian Railway, with maps and views of bridges and road construction. Serial. Part I. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 5, 1900. No. 32116 B.

The Siberian Railroad. Remarks from Russian papers criticising some points in the construction, etc. 1600 w. U. S. Cons Repts. No. 626—Jan. 12, 1900. No. 31867 D.

Signalling.

American Practice in Block Signalling. B. B. Adams. The first of a series of articles giving a thorough revision of matter published eight years ago, and aiming to treat the subject from a practical standpoint. Ill. 2000 w. R R Gaz—Jan. 5, 1899. Serial. 1st part. No. 31-759.

Automatic Block Signalling. Edward C. Carter. Compares the semaphore and disc signals, stating the objections to each and discussing their operation and maintenance, installation, etc. 3500 w. R R Gaz—Jan. 12, 1900. No. 31874.

Automatic Interlocking at Hawley, Illinois. Illustrated description. The features of interest are the use of automatic brake-setting devices, and the use of "power-storing" machines for throwing all of the signals. 3000 w. Ry & Engng Rev—Jan. 6, 1900. No. 31778.

Railway Signalling in America. Reviews recent papers by H. M. Sperry, A. J. Wilson, and Frank Rhea. 2200 w. Engr, Lond—Dec. 29, 1899. No. 31828 A.

Signalling as It Is and as It Might Be. A. H. Rudd. Part first gives a review of the progress of signalling. 1700 w. R R

Gaz—Jan. 26, 1900. Serial. 1st part. No. 32081.

Supplements to Railway Signalling (Brierley's Apparatus). An illustrated description of an arrangement for giving indications on the engine itself, to avoid danger in fogs. 2000 w. Elec Rev, Lond—Dec. 29, 1899. No. 31816 A.

Terminal Improvements.

Great Northern Terminal Improvements at Seattle, Wash. Plans and description of a proposed union passenger station, yard tracks, etc. If not approved as a union station, with slight changes the plans will be carried out as a station for the road named. 1200 w. Ry & Engng Rev—Jan. 27, 1900. No. 32237.

Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Continued discussion of paper by Walter W. Curtis. 3300 w. Pro Am Soc of Civ Engs—Dec., 1899. No. 31706 E.

Track Elevation.

Track Elevation in Chicago. Commences an illustrated description of the extent and character of the work done by each railway company. Also editorial. 7500 w. Eng News—Jan. 11, 1900. No. 31864.

Ventilation.

The Ventilation of the St. Gotthard Tunnel (La Ventilation du Tunnel du Saint-Gothard). A detailed description of the Saccardo system as installed at Goeschenen for the maintenance of a constant current of air through the tunnel; with graphical diagrams showing the velocity of the air. 5000 w. 1 plate. Rev Gen des Chemins de Fer—Nov., 1899. No. 32132 G.

STREET AND ELECTRIC TRAMWAYS

Aberdeen.

The Aberdeen Corporation Electric Tramways. Illustrated detailed description. 1400 w. Tram & Ry Wld—Jan. 11, 1900. No. 32066 A.

Berlin.

Tramway Projects in Berlin. D. B. Macgowan, in the *Chicago Tribune*. An account of the lines under construction and in operation. 1900 w. Tram & Ry Wld—Jan. 11, 1900. No. 32067 A.

Brooklyn.

The Traffic Difficulties of the Brooklyn Rapid Transit System. An illustrated discussion, with maps, showing the difficulties and transportation trials, and considering the only remedy to be the increasing the dry land communication between Manhattan and Brooklyn. 2200 w. St. Ry Jour—Jan. 6, 1900. No. 31801 D.

Changing Power.

Opening of the Third Avenue Railway, N. Y. Illustrated account of the changing of the main lines of this railway from cable to electricity, using the underground conduit system. 3600 w. St Ry Jour—Jan. 6, 1900. No. 31800 D.

Como.

The Electric Tramway at Como (Die Elektrische Strassenbahn in Como). R. v. Podoski. Giving details of the wiring of the motor cars and the construction of the trucks. Also diagrams showing the operation of the brakes on steep inclines. 3000 w. Elektrotech Zeitschr—Jan. 4, 1900. No. 32167 B.

Controller.

Saving at the Controller. J. R. Cravath. Considers how current is usually wasted in operating cars and gives suggestions concerning instructions that should be given motormen. 2200 w. St Ry Rev—Jan. 15, 1900. No. 31999 C.

Development.

Electric-Railway Development of 1899. James R. Chapman. Review of progress and the tendencies in construction and equipment. 1200 w. W Elect'n—Jan. 6, 1900. No. 31805.

Efficiency.

The Relation between Receipts and Car Efficiency in Street Tramways (Beziehungen Zwischen Einnahmen und Wagen Kilometerleistung bei Strassenbahnbetrieb). W. Mattersdorff. Giving a number of diagrams plotted from German tramways, showing the commerical advantages of high car-mile efficiency. 2000 w. Elektrotech Zeitschr—Dec. 21, 1899. No. 32164 B.

Electric Locomotives.

Some Recent Electric Freight Locomotives. Burcham Harding. Describes and illustrates a novel type for hauling freight cars over electric lines. 600 w. Eng. News—Jan. 25, 1900. No. 32075.

Electric Railway.

The Detroit, Ypsilanti & Ann Arbor Electric Railway. Illustrates and describes this example of modern practice in the equipment of an interurban traction system. 3500 w. St Ry Rev—Jan. 15, 1900. No. 31997 C.

Electrolysis.

The Prevention of Electrolysis. Alton D. Adams. Discusses the damage from currents of electric railways, the conditions that produce ground currents and the remedy. 3000 w. Munic Engng —Jan., 1900. No. 31699 C.

Energy Distribution.

Distribution of the Energy of a Pound of Coal in the Electric Railway Cycle. Albert B. Herrick. Diagram showing in a graphic way the magnitude and location of the various losses in street railway operation. 1500 w. St Ry Jour—Jan. 6, 1900. No. 31799 D.

Feeders.

Aluminum Feeders on the Northwestern Elevated Railroad, Chicago. Illustrated description of the installation and the methods used in handling the wire and manner of overcoming difficulties. 2000 w. Am Elect'n—Jan., 1900. No. 31797.

Gas Traction.

Gas Traction on Tramways at Blackpool. Lytham and St. Annes. W. Chew. Read before the Manchester Dist. Inst. of Gas Engs. Information concerning this line successfully worked by gas. 1500 w. Gas Engs' Mag—Jan. 10, 1900. No. 32223 A.

Italy.

Electric Traction on the Secondary Railways of Italy (Essais de Traction Electrique sur les Lignes de Chemins de Fer Secondaires en Italie). R. Godfernaux. Describing the various lines now in successful operation in Italy, with data concerning costs and returns of operation. 5000 w. 1 plate. Rev Gen des Chemins de Fer—Dec., 1899. No. 32135 G.

Milwaukee.

Milwaukee Electric Tramways. An Illustrated description of the installation. 2500 w. Tram & Ry Wld—Jan. 11, 1900. No. 32065 A.

Omnibus.

See Mechanical Engineering, Automobilism.

Paris.

Electric Traction in Paris. Illustrates and describes the novel features in construction. 1800 w. Elect'n, Lond—Jan. 12, 1900. No. 32025 A.

Public Transportation Facilities in Paris and its Vicinity (Les Transports en Commun dans Paris et sa Banlieue). Charles Jean. A review of the present and proposed facilities, including omnibuses, horse, steam, and cable tramways, and steam railways, in view for the heavy demands upon the service expected during the Exposition. Serial. Part I. 3500 w. Génie Civil—Jan. 13, 1900. No. 32108 D.

Power Stations.

New Main Power Station of the Third Avenue Railroad Company, New York. Illustrated detailed description of the structure, which will be the largest station in the world, and the main features of the steam plant. 9000 w. St Ry Jour —Jan. 6, 1900. No. 31798 D.

The New Power Station of the Third Avenue Railroad Company. Illustrated description of a 72-000-H. P. station in New York, used for distributing 3-phase current from railway service. 2200 w. Eng Rec—Jan. 6, 1900. No. 31767.

The New Street Railroad Power Stations in New York City. Brief illustrated descriptions of the stations of the Metropolitan Co., and the Third Ave. R. R. Co. 1200 w. R R Gaz—Jan. 12, 1900. No. 31876.

Rail Wagon.

The Bonner Rail Wagon. Illustrated description of an invention for cheapening transportation and the handling of freight in connection with electric trolley roads. 700 w. Sci Am—Jan. 13, 1900. No. 31845.

Statistics.

The Statistics of the Electric Railways of Germany (Statistik der Elektrischen Bahnen in Deutschland). The annual tabulated statement, giving data for existing and proposed roads, and a general summary down to September 1, 1899. 10000 w. Elektrotech Zeitschr—Jan. 4, 1900. No. 32170 B.

Suspended Road.

The Suspended Railway between Barmen, Elberfeld, and Vohwinkel (Die Schwebebahn Barmen-Elberfeld-Vohwinkel). Illustrated account of the curious railway connecting Barmen and Elberfeld, with their suburbs. The cars are hung from single overhead rails, and propelled by electricity. 1200 w. Deutsche Bauzeitung—Dec. 23, 1899. No. 32182 B.

Switzerland.

The Full-Gauge Electric Railway between Burgdorf and Thun (Die Elektrische Vollbahn Burgdorf-Thun). E. Thomann. With map and profile of the route, and views of the motor and trailer cars. The three-phase current is used. Serial. Part 1. 1200 w. Schweizerische Bauzeitung—Jan. 6, 1900. No. 32139 D.

Tracks.

Track Construction for Electric Railways. F. A. Vaughn. Illustrated discussion of important points in construction and maintenance, with description of present practice for urban and interurban lines. 3500 w. Wis Engr—Jan., 1900. No. 32014 D.

Track Construction in Buffalo. Illustrates and describes the trench construction, and smooth excavation construction, and the organization of the laborers. 800 w. St Ry Rev—Jan. 15, 1900. No. 32000 C.

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